

***The Development of Vulnerability and
Resiliency to the Plague:***

***from the ‘Big Bang’ of Yersinia pestis, Black Death
and the Continued Geographic Expansion of the
Zoonotic Outbreaks to the Present***

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Preface

My purpose in this section is to explain some of the background to this thesis. I begin by speaking of my own experiences and how that shaped the concept for this research and the plan to implement it. The second half of the Preface, discusses the progression of the research in relation to the people who have influenced me along the way, as well as those who have guided this interdisciplinary work in the field of their expertise. This thesis has depended upon many people over the years. It helps illustrate voices and realities not often heard that are needed to better understand and deal with zoonotic disease epidemics. This includes contributory factors such as ecological crisis, food insecurity, and unsustainable socio-economic systems and institutions, and factors which promote resiliency.

My professional life with the focus on vulnerability and resiliency

My first degree was in Sociology and my professional experience includes working as a Counsellor and Job Developer with youth and adult prisoners (respectively), as well as working with youth and adults who had been diagnosed with disabilities while also being in poverty. My past clients and students were often at very significant risk due to illness, disease, disabilities, as well as socio-economic systems and institutions (e.g. education and prison systems and institutions). They often had limited exposure to life outside of these institutions and lacked the confidence and knowledge to take the steps to access the services and resources that they needed. Since, most of my clients and students were also coming from households below the poverty line, the available time and financial means to pay for what they needed was also very limited. Thus, lifespans were significantly lower than the mainstream society. This was especially pronounced in the youth prison and the Esperanza School-Chicago where I would estimate the average life span was halved.

I obtained a degree in Special Education in order to assist students with special needs be more independent knowing they would not receive much support from social service agencies. My coursework largely concentrated on subjects in educational psychology and my focus was on increasing students' resiliency and independence even when faced with very difficult circumstances. My teaching

experience began in 1998 at the Esperanza School in Chicago, where I won a Walmart sponsored Chicago Teacher of the Year award (1999) for my first year as a teacher. I had the oldest students at the high school, where I was teaching students labelled with moderate to profound disabilities and almost all were also coming from impoverished families. I was teaching these students to survive and hopefully live happy, productive lives through learning the resources in their neighbourhood, how they could access these resources, and taking an active working role at a couple sites through a volunteer programme I started and expanded with the collaboration with other teachers. I continued my teaching in Buenos Aires, Argentina where I taught Environmental Management, Economics, Sociology, and History to high school students. Many of my students also volunteered their time after school hours to assist with a signature campaign for the Hok Tek T'oi Wichi community to gain the rights to their land, as well as a food and clothing drive for the community. I have also worked as a consultant to a couple social service agencies in Liverpool, UK that were assisting parents and students with diagnosed disabilities in a bureaucratic system that has suffered sharp cuts in the last couple of decades.

The beginning of my research into human zoonotic epidemics actually started with the Hok Tek T'oi Wichi community (Salta province, Argentina) who have been suffering from a Chagas epidemic for decades. The community was saturated with the main insect vector that transmitted the disease, the Vichuga beetle. In my first stay in August 2006, I realised it was really not possible to live there without being bit by the pest. However, the eldest in the community, Roque, informed me the Chagas disease only became an epidemic when they were forced to settle due to the expansion of the deforestation and soy plantations. The beetles became “domesticated” on the people and their animals, as these larger varieties were no longer able to live wild in the forest.

It was here with the Wichis where my thought that human zoonotic disease may actually be a socio-economic problem at its roots, and accordingly I started my research on human zoonotic disease epidemics. I ended up focusing on Black Death of the mid-14th century as unlike the Justinian Plague at the end of the Roman Empire, the socio-economic systems and institutions, though affected by

the pandemic, largely carried on. This is where I believed the socio-economic roots of our ecological problems lay. The European Middle Ages began with relatively de-centralized socio-economic and political systems. The strong pull for centralized rule in the eleventh, twelfth and thirteenth centuries was sufficient enough to unite the continent through the Church and secular powers (a phase which has been dubbed 'The Making of Europe'). I thought Ireland would be a good case-study area as it was on the European frontier during this centralisation process and it had only been partially colonised by England by the mid-fourteenth century.

Complex problems and the need for interdisciplinary case studies

I come from a professional background in social work and special education where individual and community assessments are done by bringing different relevant professionals and stakeholders around the table, where everyone contributes to the understanding of the issues being addressed and then discuss ways to address these issues. Part of this group investigation would also entail a history of the individual or community in the context of the development of the issues being discussed. This evolutionary approach allows for a greater understanding of a particular time and place as an inherited context, which also leads to a greater capability to identify the root of the problem rather than just addressing the symptoms. This interdisciplinary/transdisciplinary approach has supplanted the field-specific, especially for complex issues, as many factors would not be adequately addressed using a mono-disciplinary approach. This interdisciplinary/transdisciplinary approach is the same type of collaboration that I wish to foster in my research. Interdisciplinary study invites collaboration in order to bring expertise from different fields in order to more comprehensively understand, and in some case effectively solve, complex problems. The collaboration of the natural and social sciences, as well as stakeholders and other bearers of relevant knowledge (i.e. practitioners of indigenous knowledge of a particular cultural geography) allows a fuller picture of the phenomenon being analysed. It facilitates more sustainable findings that can last the test of time and contributes to the taming of complex problems in the

present. This multi-disciplinary collaborative approach can also help avoid such problems from re-occurring in the future.

Globalisation & Environmental Change Realised Through Personal Taiwanese Connection

“Why is the sky blue?”

The first observation of a 17-year old Hui-ju (Charlene) Chen recalled to me when she landed in 1989 in Buenos Aires, Argentina from Taiwan was the question, “Why is the sky blue?” She had never seen a blue sky in Taiwan and thought pictures of other places that she saw were just doctored to make the sky appear blue. Charlene and I met in 1995 and were married between 1998 and 2010. Through that time I came to know much of her and her family’s experiences through the country’s rapid socio-economic and ecological changes. I remember a conversation with Charlene and her dad, about her dad swimming in a river when he was young that stopped when he began to have repeated infections, and then the islanders having to boil water as a way of life to have access to drinking water. Air pollution was to the degree where some wore masks to protect themselves from the pollution and there have been extremely few trees or greenery in the cities since heavy industrialisation took hold. Zoonotic disease was also on the increase in Taiwan as seen in 1997 when there was a Foot and Mouth epidemic that led to almost 4 million pigs being slaughtered in one of the densest pig populations in the world.

A dramatic change has been taking place in the enculturation of the people from generation to generation. During her grandmother’s generation Taiwan was an agricultural nation and the only language her grandmother learned to read was Japanese syllabary. Though the colonial period was only 50 years, the transformation of Taiwan continued during the post-colonial period as the industrial sector continued to grow after WWII. Charlene’s parents were professionals in this changing economy, as her father worked for the Taiwan Power Company (TPC) and her mother in the accounting department for the

municipal government. During Charlene's childhood there was the manufacturing boom, where an increasing emphasis was put upon western science and technology. At the same time Charlene's mum was using an abacus for her calculations at work.

Charlene attended classes after school and informed me that she would typically only have 5 hours of sleep a day due to the amount of school and after school classes and homework. There was a continual competition amongst pupils for the highest ranking in class, based on examinations focused on maths, physics, chemistry, and English. The national exam test scores would determine what school a student could get into as well as the field. Medical school was the most respected field, which typically students with the highest scores would attend, if they were interested in the field or not. Charlene's best friend, who committed suicide after she was not able to get into the best medical school in the country, was an example of how much importance was put on these exam scores.

The classes and teaching methodology also dramatically changed in Charlene's lifetime. When Charlene was attending school, language study, reading, literature, history, and philosophy were interwoven and students saw how Taiwan evolved in its 4-5 thousand year history. The first time Charlene heard of Chinese/Mandarin grammar was when she studied in the U.S. in her mid-20s. However, the present generation strictly studies Mandarin grammar, and the study of the past is largely limited to the last hundred years.

The amount of effort which has been put into a western-based curriculum, has led students to be enculturated in a western mindset and little focus on their own culture. It seemed as though westernization was deemed the most effective way to stop being disrespected. Evidence of this belief extends to physical appearance, the most common plastic surgery in Taiwan is to gain the "triple eyelids" to look more like Western eyes, where "single eyelids" have been shunned by the beauty industry. Parents often push their children into western fields as western medicine and engineering that are especially highly valued, but are outside of the Chinese tradition. However, other areas of employment also

have extremely strict rules or measurements for potential applicants to be considered from airline attendants' physical measurements to sales employees often not only have to say particular lines to customers but having to practice the "correct" mannerisms and tone of voice. This belief that gaining respect is against the odds has led to a particular view of perfectionism that has permeated Taiwanese society and almost everyone is judged by. Additionally, the marketing of western-style products has transformed consumption with a focus on digital technology, while outdoor activities have remained quite limited.

The great amount of hours students spend studying means that that schools have huge impact on young people, generation after generation. Family life can be quite difficult as parents work long hours to support their children's education, but the time spent with kids helping them to learn about other aspects of life, is quite limited. This along with the dramatic educational changes often leads to a difference between generations so that communication issues and a lack of understanding is often particularly profound in Taiwanese families. The "Asian Tiger" countries have been given a lot of credit for their economic growth, but there is also sorrow/depression, high suicide rates, and other mental health issues that may be linked to the de-valuation of the societies own cultural attributes. For instance, young people have often lost esteem for Chinese medicine, which focuses on the health of the immune system instead of focusing on the symptoms of particular pathogens and ailments that is seen in much esteemed Western medicine.

Now Taiwan is a country with few natural resources and depends greatly upon imports. Recently, the country has shown great vulnerabilities to mud-slides due to hillside de-forestation, as well as many other potential environmental crises including zoonotic epidemics, due to the dramatic urbanisation and extraction of resources that has transformed the landscape. Also, the disconnection people feel to their local ecologies and cultural past has led to many other issues that has had a dramatic effect on the society's capacity to withstand a recession, as the island is not close to being self-sufficient.

The Progression of the Research

The fundamental goal of my research has been to find the root causes for our dysfunctional human activity that increases our vulnerability to ecological crisis, food insecurity, and ultimately human zoonotic disease epidemics. It has been my belief that our present enculturation in globalization has its roots in the Middle Ages, which led me to the University of Aberdeen where I received an MLitt in Medieval Studies under my supervisor, Clare Downham. My thesis, *Agallamh na Senorach as a Case Study into the Socio-Economic Environment in the late Twelfth/early Thirteenth Century Western Ireland*, which I argue is ultimately a story about the threat of survival in a transitional period (which is thought to be at the end of the 12th century). This is a story of St. Patrick and Caílte's (a member of the *fianna* in the Fenian Cycle of Irish mythology that had followed indigenous tradition) journey to re-interpret past traditions, which are illustrated as a threat for those that continued to follow the accumulated wisdom of the past. Patrick and newly converted Caílte bring a new understanding of these traditions that are said to be inspired through the spiritual power of the Church. This ecclesiastic interpretation was grounded in the flawless, definitive and unchanging Holy Scriptures (verses the oral tradition, which is brought out to be vulnerable to change and mis-interpretation). The inspired path that they set on this journey is shown to have led to an abundance of wealth, and a glorious, righteous future.

Agallamh na Senorach is interesting as it is a story that takes place as Ireland is confronted with the advancement of colonization from English secular and ecclesiastic hierarchical institutions that are centred outside Ireland. My thesis attempted to illustrate the context of the story, especially with regard to local socio-economic systems and institutions that depended more on the cultural geography that people lived in versus the trade-based socio-economic systems and institutions based in England and the Continent.

Research path at the University of Liverpool

I followed Clare to the University of Liverpool where I received support from the Institute of Irish Studies Fund to start my PhD. The next stage of my research

focused on infectious disease ecology to better understand the context in which human zoonotic epidemics typically take place. Through the guidance of Mike Begon and Anne Laudisoit and with the support of some background research, I established vulnerability factors for a human zoonotic epidemic that could be applied to this work, which were fundamental research assessment tools for my PhD dissertation. This research was further assisted in August/September of 2013 with the Soil, Land Use, and Health conference that largely focused on the Bubonic Plague outbreaks in the Lushoto district in highland Tanzania, which I, focusing on medieval Ireland, was one of the speakers. Health Geographer Didas Kimaro and other researchers brought a small group of us to different sites where the Plague outbreak was especially intense and nearby sites that suffered only a minor outbreak. Didas Kimaro and I spoke at length during the conference and he reviewed and commented on the chapter, *Societal Change and Vulnerability to Zoonotic Disease Epidemics: An assessment of the impact of escalating globalisation with a focus on Tanzania from the eve of colonialisation to the recent past*. Anthropogenic change of the landscape, ecologies and biological systems creating the context for zoonotic disease created the framework for my research observations to come together whether speaking of zoonotic outbreaks in medieval Europe or modern eastern Africa. It is remarkable that anthropogenic ecological transformation based from socio-economic systems and institutions that changed from local control where a people largely survived on the ecological systems around them to an externally controlled system that promoted the large-scale production of a few commodities for external markets has been expanding and intensifying since the Middle Ages.

Palaeoecology & Cultural Geography Research in the UK, Sweden, & Ireland

My research on the medieval Irish ecology had led me to change to the Geography department in 2012 in order to incorporate palaeoecological evidence to form the ecological foundation of my research that historical and archaeological evidence would be set within. Palaeoecologist Richard Bradshaw joined Clare as my supervisors and in November of that year to April 2013, I went to Lund University, Sweden under the DYNAMITE fund to advance my

training in Palaeoecological research. During this period, I met with Per Lagerås and his research group who were investigating medieval agriculture of manorial systems and the impact of the Plague in medieval Sweden. They recently published the book, *Environment, Society and the Black Death: An interdisciplinary approach to the late-medieval crisis in Sweden*. We had interesting discussions around vulnerability and resiliency to zoonotic diseases as they were observing the breakdown of some central Swedish manors and a greater degree of resiliency in their investigation of land-use changes and susceptibility to Black Death. I also meet with Isabelle Brännlund and Peter Sköld from the Centre of Sami Research at Umea University, as well as going up to a conference and a Sami museum in Jokkmokk to discuss the Sami experience with infectious disease compared to their Scandinavian counterparts. Sköld has done research on Smallpox since the eighteenth century comparing these two populations and Brännlund has investigated Sami environmental knowledge related to reindeer herding. Additionally, I was in correspondence with Anthropologist Marilyn Walker of Mount Allison University (Canada) regarding the loss of symmetry in artwork with the greater dependency upon a trading economy and Ray Barnhardt of the University of Alaska-Fairbanks regarding indigenous knowledge systems and their connections to the ecologies they depend upon.

On heading back to Liverpool, I had new concepts and different examples of socio-economic systems and institutions leading to anthropogenic ecological change. These affected a people's ability to adapt to disease and environmental crisis and could be used to analyse the impact of Black Death in Medieval Ireland. I collected soil core examples in the west and southwest peatland areas of Ireland for pollen evidence as well as accessing previous pollen studies that covered the twelfth to the fourteenth century. I developed a GIS maps based on the pollen maps of the different sites in order to show different ecological changes happening in different regions, particularly distinct were east Ulster and the Irish Midlands. This evidence formed the ecological foundation of my research using Ireland as a case-study example of the socio-economic and ecological changes happening during the period. Ireland being in the European

frontier of the time was well suited to show the battleground of socio-economic systems and institutions and how these changes were connected to the ecological changes taking place. My supervisor Clare Downham gave me much guidance in this chapter in finding the appropriate sources as well as giving me a critical review to strengthen my arguments. Archaeologist Tadhg O’Keeffe also thoroughly reviewed the material in this chapter as he went well beyond the call of duty of the editor of the paper for the Journal of the North Atlantic and greatly edited and condensed much of the paper, while giving insightful guidance. O’Keeffe’s work was also very influential in developing this chapter.

The next component of this research involved the genome map of *Yersinia pestis*, the bacterial pathogen that causes the Plague. There has been a great deal of genomic research on *Y.pestis* that dwarfs that which focuses on other pathogens. By taking DNA samples of medieval graves of Black Death and subsequent outbreaks, the virulence and contagiousness of the pathogen was compared for mutations and adaptations over the centuries and continents and was found to be quite monomorphic. The *Y.pestis* genome map contradicted the mainstream Black Death narrative that the Black Death strain of *Y.pestis* was especially deadly and contagious. Since the biological evidence has refuted this premise, I set out to research an alternative to the mainstream narrative on how *Y.pestis* would have spread leading the mid-14th pandemic. Mike Begon and molecular biologist Linda D’Amore assisted me in this assessment of the genomic evidence of the pathogen and its relevance, which I am very grateful for as they form part of the foundation for a new, more justifiable narrative of the Black Death.

The *Y.pestis* genome map served as the backbone of the next chapter, entitled, *An Alternative Hypothesis to the mid-14th century spread of Yersinia pestis before Black Death: An interdisciplinary assessment of the characteristics of the pathogen and the Plague in its Mongolian, Tibetan Plateau, and Afro-Eurasian Context*. This work focuses on an alternative hypothesis for the spread of *Y.pestis* that was at least part of the cause of Black Death in the mid-14th century. This hypothesis uses historical and archaeological evidence to explain how ecological and

biological change may have come about, leading to the context for the pandemic to take place. This investigation benefited from Archaeologist Leonard Nedashkovsky of the Kazan (Volga Region) Federal University who has done extensive research on the Golden Horde and its interconnections with Europe, Asia, and the Eastern Mediterranean region while also studying anthropogenic and environmental changes since the Mongol expansion. Nedashkovsky's advice and knowledge of a wide variety of sources was very helpful. There are many publications in Russian that many western researchers do not access to, but which are very insightful. Mongol Historian Christopher Atwood from Penn University gave very important recommendations in regards to the early expansion of the Empire, the scale and organisation of the Mongol government, taxes, horse and domesticated herd size increase, and the state of evidence of Buddhist temple construction in northeast Tibet on the eve of and early during the Empire, as well as identifying critical research to pay attention to on the period. Atwood's knowledge of Mongol, European, and Chinese sources was brilliant for guiding this work on the Mongol experience. Climatologist Xuefeng Cui from the University College Dublin has done extensive research on central Asia and the Tibetan Plateau, in particular, which he has assessed climate changes in the region that have taken for the last few hundred years. Cui has shown the how land cover change in semi-arid landscapes affects regional and local climate change, which is important in investigating zoonotic disease outbreaks, as vulnerability factors are tied to local ecological changes. Infectious disease Ecologist Mike Begon reviewed the biological material in this work and guided me to the work of the most respected researchers in genomic Plague research. Molecular Biologist D'Amore, who was part of the team that mapped wheat genome, also thoroughly reviewed the biological material and gave me advice and guidance in understanding the research in the area. I greatly benefited from our discussions in developing the assessment of the genomic and biological material. Most importantly, she gave me the support and patience I needed to finish this work, going well beyond the call of duty as my wife.

The last chapter focuses on the how and why eastern Mediterranean, Western Asia, and Europe were generally very hard hit by Black Death, even though

Y.pestis would have been present in other regions, especially much of Asia, but there is no strong evidence to show any epidemic took place. Yosseff Rapoport kindly gave me guidance in my research into the Bedouins in the Mamluk Empire in the Arabic record, as much of the record is not translated into a European language. The medieval Arabic record gives insights that I have not seen in the European records in that there is greater attention paid to ecological and biological change and there are many observations that are very much in-line with recent Plague and human zoonosis outbreaks, which is not so true for the European accounts.

I had the opportunity to present a paper at the University of Bonn *International Conference on Environmental Approaches in Pre-Modern Middle Eastern Studies* and had the opportunity to speak extensively with different researchers that have been researching the Plague in the Mamluk Empire, largely focusing on present-day Egypt and Jordan. Jordan was on the margins of the Mamluk Empire and the Bedouin had a relatively large presence there, much like Irish Gaels. Both of these terms are used by outsiders often to identify people that they did not trust and suspected of raiding agricultural settlements and engaging in war against them. This over-generalisation of the Gaels and the Bedouins as both of these peoples were believed to have done well early in the 14th century and through Black Death. The different expertise of the researchers allowed my investigation to go further depth with the comparison of Irish Gaels and the Bedouins as well as connect the two peoples that often operated on the margins, taking advantage of trade, insecurity, different resources through social networks and mobility, though most were likely agricultural settlers as their counterparts were. Archaeologist Bathany Walker, Zooarchaeologist Chiara Corbino, and Palaeoarchaeologist Annette Hanson were very helpful in understanding what had been taking place in a few sites in Jordan, as well as insights regarding anthropogenic activities that led to these ecological changes. Anthony Quickel and Hend El Sayyed gave insight in the historic and archaeological record in medieval Cairo, while Lufallah Gari gave background on ecological change in medieval Islamic cities. I also spoke extensively with Stuart Bosch, who has been extensively researching flooding problems and the

disrepair of the levees in the Nile Valley agricultural system, which seems to have been increasingly abandoned as the presence of the Plague intensified. This conference was very fruitful for me in gaining access to material and in discussions that I would have not otherwise had, which was important in having this paper, which was largely based upon evidence in the Mamluk Empire, the Bedouins, and Arabic sources, be able to stand scrutiny from researchers from these areas.

This thesis begins with illustrating what a zoonotic disease epidemic in human populations is and how different zoonotic pathogens expanded in different contexts to eventually infect human populations on a large scale. Through these examples, vulnerability factors for a human zoonotic epidemic are introduced and explained. This is the backdrop for the pathogen that is the focus for this thesis, *Yersinia pestis*. The biological and ecological evidence (as the genome map, and the bacteria's needs of survival, capacities, vulnerabilities, and characteristics for survival in ecosystems) is thoroughly illustrated in order to give insight to the context that this author believes an expansion of the pathogen leading to Black Death took place within. Additionally, the subsequent chapters focus on the development of different cases of bubonic plague in medieval Ireland and the Mamluk Empire, as well as highland Tanzania (Lushoto district) around the turn of the 21st century. These chapters illustrate the evolution of human plague in these geographic areas that goes beyond the development of ecological and biological circumstances that were advantageous for the pathogen to expand to these geographies and human populations, but also what fostered the human activity that led to many of these ecological and biological changes to occur. This is then contrasted with the ecologies, socio-economic systems and institutions, languages/knowledge systems, and human activities that took place in the most resilient people to the bubonic plague of these geographic areas of this investigation.

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Chapter 1

A Re-evaluation of the Plague and Black Death of the Mid-14th Century

Black Death is the world's most researched epidemic in human history, so it might be assumed that its causes would be well known. However, this may not be the case as recent DNA, biological, and ecological evidence has fuelled scepticism about the common historical narrative regarding:

- the exceptionally contagious and virulent nature of the mid-14th century pathogen, *Yersinia pestis*,
- fatality rates that did not differ significantly among different population groups,
- the black rat as the dominant host of the bacterium
- the disease epicentres being urban centres
- the epidemic suddenly appeared and spread in a few years across western Asia, the eastern Mediterranean, and all of Europe

Societies often make decisions and receive funding based on how to avoid epidemics built upon these stories they have been enculturated in. However, if this famous pandemic has been misunderstood, then we risk failing to take effective action against this pathogen or other zoonotic diseases.

This chapter will give an overview of the research on what is the Plague and what leads to greater risk for a large outbreak or an epidemic, as well as incorporating this knowledge with DNA and the genome map of *Y.pestis* data to update the Black Death narrative. This overview proceeds as follows:

I. Understanding the Development of Zoonotic disease, the Plague and Black Death through Ecological Change and Human Health

1.1 *The Continued Development Zoonosis Disease as a Human Threat*

Zoonoses (infectious disease transmitted from animal reservoirs to humans) are the most common type of emerging infectious disease. These diseases are increasingly becoming a problem around the world, especially in areas of large-scale deforestation, resource abstraction, and cultivation and herding. This section explains why zoonotic diseases have been a growing problem and the relationship this has with environmental change and human activity.

1.2. The Background of the Plague Pandemics and the Historical Narrative of Black Death

The typical historical narrative that we in the West were taught in school has been that Black Death indiscriminately killed around half of Europeans and first appeared in port cities and then work its way inland to less urban environments transmitted by the black rat was a story started by an Indian ambassador in the late 19th century due to a Plague outbreak in India. However, he had not had a first hand account, nor the expertise to assess the situation, but his work nevertheless established the foundation narrative that has largely continued to the present day. This segment illustrates the evidence of the Plague in the late 19th and early 20th century, a basic review of the human experience with zoonotic disease epidemics and the big three Plague epidemics, and then defining what are the symptoms and known types of Plague that have been afflicting people for thousands of years.

The next segment reviews what leads to human vulnerability to illness, disease, especially zoonotic disease as the Plague, with a special focus on the decades leading up to Black Death of the mid-14th century. This section concentrates on the impact of cereal cash-crop production in medieval manor agricultural system on human health and is entitled,

1.3 Health and Environment prior to Black Death: Nutrition/Malnutrition, Illness, and Disease in the late 13th to the mid-14th century

The Crusades brought large-scale war to Europe and the Eastern Mediterranean and with it the need to develop wealth and large food surpluses to maintain a large military and the socio-economic systems and institutions to support it. However, in doing so there was an ecological and health consequence, as deforestation and vegetation clearance made way for cash-crop agriculture and large-scale animal husbandry. Population sizes and densities increased for people and their domesticated animals as well as commensal animal life, as rodents, while forest fragmentation and other anthropogenic behaviour led to

diminished barriers between wild animal life and humans, all of which contributed to the greater vulnerability of zoonotic disease.

The greater dependency on cereals brought with it its own vulnerabilities to the human immune system, leading to diminished capacity to fight off infection. This section explains the development of toxins in cereals and how that results in greater vulnerability to disease, as well as how agricultural settlements with grain storage increased the risk of such toxicity to occur.

II. Identifying the Environments that a Zoonotic Epidemic Takes Place within

1.4 The Development of Standardised Socio-economic Systems & Institutions Through the Centralisation of Property, Production, Economy, Society, & Thought

The standardisation of societal institutions to become more complex bureaucratic systems allowed for greater centralization of extensive territories to occur within socio-economic systems that were based upon rapid wealth accumulation through large-scale resource abstraction, herding and agricultural cultivation and trade. The high demand for certain commodities led to the alteration of landscapes to harvest these commodities over extensive regions. This meant that human labour and activity was also standardised in order to attempt to develop that which the market demanded in the most systematic fashion. Accordingly, market factors of weight and bulk became key measures that guided the labour, as it was these factors that resulted in greater profits. This was a significant break from ecological-based observation of societies who largely lived within their cultural geographies.

1.5 Assessing Socio-Economic System & Institutional Ties to Human Zoonotic Epidemics Through Modern Outbreaks

This section analyses socio-economic system and institutional changes since the mid-19th century, thereby being able to assess these changes in more detail than would be possible in a medieval assessment alone. The premise here is if it is accepted that human activity plays a crucial role in the spread of zoonotic disease, then it is important to find out what leads people to conduct such

activity that heightens their risk of contracting disease. Before these hazardous actions are conducted, there was a thought process that supported these activities. Therefore, this section covers the societal transformation of knowledge systems (particularly through language, education, and mass media) from those based on a particular cultural geography to one based on a wider cash-based, trading economy.

1.6 The *Y.pestis* Genome, its Characteristics and Environments that it has Flourished and Declined

The biological evidence of *Y.pestis* and the development of the Plague has been greatly advanced recently through Bos et al and Cui et al. genomic studies on the pathogen. The characteristics of *Y.pestis*, how it would survive and thrive and where it would decline also helps us understand who would have been at greater risk of contracting the Plague and who would be at less risk. Socio-economic factors play a crucial role here that leads to other factors as human activity, food security/nutrition, and population density that lead to very significant differences in the degree of Plague infections and fatality rates in human populations.

1.7 Rethinking Black Death

The common belief that *Y.pestis* spread rapidly just before Black Death occurred in the mid-14th century is not supported with the biological evidence in that the genomic evidence of DNA samples indicate that the pathogen was not distinct from the modern bacteria. There is no evidence that the medieval pathogen would have been especially contagious or fatal, as has been a core argument to suggest the rapid spread of the pathogen. This section follows characteristic of *Y.pestis* that has caused modern outbreaks, which includes typically going years, decades between human outbreaks while the pathogen survives in animal reservoirs.

Retracing the “Big Bang” of *Y.pestis*, which is thought to have come about in the vicinity of the Tibetan Plateau, leads to another great expansion, that of the Mongol Empire that quickly spread across Asia into Europe from the early to mid-13th century. In order for the Mongols to accomplish this they needed to

develop the short-term wealth in order to support their military and their supporting horses and livestock across the vast semi-arid central Asian landscape and into more temperate western Asian and European geographies. The development of the ecological context for *Y.pestis* expand in number and spread from central Asia to Western Asia, the Eastern Mediterranean and Europe entails first observing the data on vegetation change, as well as information on domestic animal and human population densities. This ecological context shows a homogenisation of the landscape, thereby diminishing the need for *Y.pestis* to mutate to survive. This along with the DNA evidence illustrating that the bacterium seen in medieval gravesites as no more inherently virulent or contagious as seen in modern outbreaks. Additionally, evidence of modern outbreaks shows the ability of the pathogen to survive in animal reservoirs for decades and possibly also periods in the soil in between periods of human infection. These long periods between human outbreaks is also seen in the historical record in Europe and the Eastern Mediterranean, though re-emerging in the same geographic areas suggesting it was still surviving in the local ecology.

1.8 Establishing Risk for Populations during Black Death

The next segment focuses on establishing risk during Black Death based from modern research of *Y.pestis*, the Plague, what we know of populations of greater and lesser risk in the mid-14th century as well as recent populations that have been exposed to the disease. This section reviews examples of those that had been inflicted with the Plague in comparison to those that were not. The goal here is to refine socio-economic characteristics of a people that fosters vulnerability or resiliency for a Plague epidemic through instigating certain human activity and change to the landscape and ecosystems in and around where the people live. It is hoped that gaining these characteristics will assist in the development of an assessment tool to be able to predict a community's risk for a zoonotic epidemic.

1.9 Case Studies on the Plague and Black Death and the Interdisciplinary, Qualitative Case-study Research Methodology

Many studies of the Plague and Black Death often use quantitative data to assess risk, but qualitative evidence has been seen as more dependable (Eisen and Eisen 2007: 1816) as the differences in the settings may be profound with a high degree of flux making accurate mathematical modelling difficult (Hassell *et al.* 2017: 64; Silvia 1997:8). Thus, this study has used a case-study research methodology based on interdisciplinary qualitative research in order to account for different factors that otherwise may not be seen and compare assessments on a case by case basis using seven criteria to compare the different sites. This case-study comparison then is able to compare areas from different geographic areas and historical periods that had been affected by the Plague. This research focused on central Asia, where *Y.pestis* of the Black Death was thought to be brought over from, to medieval Ireland and the Mamluk Empire in the eastern Mediterranean, as well as a recent Plague outbreak in the Lushoto district in highland Tanzania.

I. Understanding the Development of Zoonotic disease, the Plague and Black Death through Ecological Change and Human Health

1.1 The Continued Development Zoonosis Disease as a Human Threat

More than 60% of human infectious diseases are caused by pathogens shared with wild or domestic animals. Zoonotic disease organisms include those that are endemic in human populations or enzootic in animal populations with frequent cross-species transmission to people...These organisms are responsible for a substantial burden of disease, with endemic and enzootic zoonoses causing about a billion cases of illness in people and millions of deaths every year. (Karesh *et al.* 2012: 1936–1945)

Zoonoses, which are infectious diseases from animals that are transferred to humans, are increasingly common. As barriers between animal populations and humans are lowered, while ecological biodiversity, complexity and quantity of non-cultivated species of plants, animals, and insects diminish in number, humans give vectors a more present host. Morse *et al.* (2012) exemplify this

human presence as a host by estimating,“(h)uman pathogens from all taxa contain zoonotic species. Roughly 80% of viruses, 50% of bacteria, 40% of fungi, 70% of protozoa, and 95% of helminthes that infect human beings are zoonotic. Most of the identified reservoirs are mammalian (roughly 80%) or, to a lesser extent, avian, although people share some pathogens with invertebrates, which act as vectors’ or intermediate hosts” (Morse *et al.* 2012: 1956–1965). The variety of known zoonotic taxa that are adapted to humans is a statement of how incorporated we are to the ecologies we live in, or at least exposed to. Thus, as people are increasingly exposed to, or living in, different ecological environments, the greater these percentages of zoonotic taxa that infect humans will be. Karesh *et al* (2012: 1936–1945). explains this increasingly changing relationship of people, natural environments, and zoonoses:

Many zoonoses can be linked to large-scale changes in land use that affect biodiversity and relations between animal hosts, people, and pathogens. Land modification, irrespective of reason, changes vegetation patterns, vector and host species dynamics (eg abundance, distribution, and demographics), microclimates, and human contact with domestic and wild animals. All these factors are crucial in disease ecology.

The process of this changing relationship between humanity and the natural environment is seemingly infinitely complex. The complexity of this relationship changes on the macro-level with the pollution and contamination of our atmosphere, hydrosphere, lithosphere, and biosphere in a systematic way as a by-product of the global economy. However, the complexity of this relationship is intensified in some local areas where the extraction of resources and/or industrial production is especially intense. These areas of ecological simplification and contamination have been the areas of especially high vulnerability:

Emerging zoonoses are the product of socio economic and anthropogenic environmental changes. For example, the domestication of livestock that led to the emergence of measles is paralleled by more recent intensification of global food production that contributed to the emergence of variant Creutzfeldt-Jakob disease and other zoonoses. Expansion of road networks, development of agricultural land, and

intensification of wildlife trade have caused novel pathogens to emerge from wildlife (eg Nipah virus, SARS, and HIV). Furthermore, the expansion of trade routes, which contributed to the spread of Black Death in the 14th century, has continued in the era of globalization, with the concomitant spread of SARS, West Nile virus, influenza A H5N1, and monkeypox. (Daszak 2012: 1883-1884)

Daszak (2012) illustrates humanity's ever-changing relationship with natural ecosystems is accelerated due to our largest population in history along with our dependency on the greatest amount of resources per person that the earth has ever seen. We have more migration and population movement, which leads to a greater species introduction rate of everything from single-celled organisms to insects, plants, animals, and, of course people. People have immune systems based upon the environment they are living in. Therefore, the changing of environments can lead to greater vulnerability, either for those that are migrating or for those who are native to an area that is being dramatically altered. These centres of mass resource exploitation have become more common as Vourc'h, Plantard and Morand (2012: 292) note , "Over the past 50 years, human activity has altered habitats and reduced biodiversity on an unprecedented scale that comes to mass extinction. At the same time, new infectious diseases seem to be emerging at an increasing rate"

The greater vulnerability of an infectious disease outbreak in a simplified ecosystem not only affects humans but invertebrate (i.e. *Nosema bombycis* parasites causing Pébrine in silkworms) (Bhat, Bashir and Kamili. 2009: 1519-1523) and vertebrate wildlife. Daszak, Cunningham, and Hyatt's (2001:103-104) research on emerging infectious disease ("diseases that have recently increased in incidence or geographic range, recently moved into new host populations, recently been discovered or are caused by newly-evolved pathogens") found:

Strikingly similar underlying factors drive disease emergence in both human and wildlife populations. These are predominantly ecological and almost entirely the product of human environmental change. The implications of wildlife EIDs are twofold: emerging wildlife diseases cause direct and indirect loss of biodiversity and add to the threat of zoonotic disease emergence. Since human environmental changes are largely

responsible for their emergence, the threats wildlife EIDs pose to biodiversity and human health represent yet another consequence of anthropogenic influence on ecosystems.

Daszak, Cunningham, and Hyatt (2001) illustrate these similarities of vulnerability factors for emerging infectious disease on the chart below:

Table 1.1 Daszak, Cunningham, and Hyatt's (2001:108) chart of the common vulnerability factors for Human Emerging Infectious Disease (EIDs), domestic animal EIDs, and Wildlife EIDs.

Human EIDs	Domestic Animal EIDs	Wildlife EIDs
International travel & commerce	Global introduction of domestic animals	Introduction of domestic & wild animals to new habitats
Demographics: population changes, migration, encroachment into wildlife habitat, cultural changes	Increased animal population density due to intensive farming	Concurrent human & domestic animal population expansion and encroachment. Reduced available habitat.
Changes to agriculture & food processing	Intensive farming practices	Agriculture
Climate: ENSO	Climate: ENSO	Climate: ENSO
Global climate change	Global climate change	Global climate change

Daszak, Cunningham, and Hyatt (2001: 112) also see human activity in creating significant ecological change as the greatest common link for these EID's as they conclude:

We have described a group of wildlife diseases that can be classified as emerging in the same way as human EIDs. These represent a link in the chain of emergence of human and domestic animal diseases, with pathogens, habitats and environmental changes shared between these populations. Parallels between causes of emergence across these groups of diseases demonstrates an important concept: that human environmental change may be the most significant driver of wildlife, domestic animal and human EIDs.

Present-day epidemics suggest that differences in human activity and the economic systems that support it are key factors in predicting vulnerability areas for an epidemic (Jones *et al* 2008:990-993; Mboera *et al.* 2013; McMichael 2004: 1054-1057; Wilcox and Gubler 2005: 267-268).¹ Specifically, areas of agricultural intensification, especially mono-cropping of grains for trade, have been seen as vulnerable to food insecurity, as well as modern day bubonic plague and other infectious disease outbreaks (Daily and Ehrlich 1996:327; Eppinga, M.B. *et al.* 2009: 53-68; Hassell *et al* 2017:55; Hieronimo *et al.* 2014; Hieronimo 2013; McCormick and Summer 2003; McMichael 2004: 1049-1058; Moses 2013).² Additionally, these cultivated areas are more vulnerable to changes in climate, levels of precipitation, insects, and plant disease. Furthermore, these cultivated regions of diminished ecological diversity may be conducive for quick breeding opportunistic species over other native species to the area as opportunistic animals, microbiological organisms, and weeds show greater adaptability to a greater variety of food sources.

1.2 Human Interaction with Zoonotic Hosts, Vectors and Pathogens

As noted earlier, humanities relationship with the natural environments is important to observe and analyse. However, this complex relationship may be especially informative on less obvious life: the insect (which is often the vector for a zoonotic disease) and the microbial levels. As the plant and animal life changes, so do the insects that need them to survive. Those insects that are able to be more flexible and adaptable and can survive using a new host may prosper in such a circumstance. We may be the hosts that these insects depend upon, Friggens and Beier (2010: 809-20) explain this aspect of their research findings:

There were clear and statistically significant associations between anthropogenic disturbance and mammal and flea community structure. Most measures of flea infestation increased with increasing disturbance...and variables associated with increased risk of disease spread and transmission, in particular number of mammals and fleas collected, prevalence and intensity of infection.

The impact of anthropogenic disturbance not only affects mammal and flea community structure, but also richness and diversity of mammals, birds, and fleas has been observed to decline (Friggens and Beier 2010: 809-20; Vourc'h, Plantard, and Morand 2012: 295; Wilcox and Gubler 2005:263-272). Certainly there would be various affects depending on what type of anthropogenic activity was taking place, but the loss of biodiversity appears to increase vulnerability for a zoonosis epidemic. These anthropogenic disturbances have been positively correlated with "flea-borne disease spread, namely infestation levels, greater flea exchange and higher flea host utilization. Disturbance also facilitates greater flea exchange and higher flea infestation levels through its effect on diversity, which may favour generalist host and vector species" (Friggens and Beier 2010: 818). These anthropogenic disturbances that result in the simplification of ecological systems may be creating habitats for population booms of opportunistic species. These thriving communities then often serve as pathogen reservoirs and vectors are common concerns (Friggens and Beier 2010: 818; Vourc'h, Plantard and Morand 2012: 304). Friggens and Beier (2010: 814-16) explain:

It is generally accepted that increased anthropogenic activity leads to decreased ecosystem heterogeneity and stability which has several repercussions for disease transmission. In particular, changes in diversity can have many consequences for flea community structure with direct implications for disease spread. First, ecosystem simplification can favour host species that are natural reservoirs or good intermediate hosts for zoonotic disease...

It is clear that fleas in more disturbed sites tend to inflect a greater number of species. In addition, flea exchange among host is known to increase with the percentage of host infested, and prevalence increased with greater disturbance in this study. Clearly anthropogenic activity can potentially increase disease risk through changes in flea host utilization patterns.

These opportunistic species tend to have high fitness (birth rates) and quickly grow to adult size. These traits may indeed be biological trade-offs made with long life spans, as growing tissue and system complexity over a long-term is costly in terms of the energy it requires. Subsequently, there may be a

relationship here between these opportunistic species having a less developed immune system due to the rapid development of typical opportunistic species (i.e. rodents) and their vulnerability to be pathogenic carrier. This arguably may make these more flexible and adaptable species that can cross into different ecological niches for food, as ideal targets for parasites. However, the problem for insect vectors and pathogen parasites living on rodents is that their short lifespans forces them to find another host. Thus, those rodents that are “domesticated” to live around human settlements, the possibility of insect vectors to jump to humans or their domesticated animals is high. Consequently, as anthropogenic disturbances intensify the conditions for these opportunistic (generalist) species to greatly increase in population, so do the possibilities for disease transmission. Vourc’h, Plantard and Morand (2010: 816) argue that biodiversity affects this interconnection between thriving generalist species, infected fleas, and parasite pathogens:

These generalist host species...often carry more diverse flea loads (number of fleas/host), both of which are associated with increased disease transmission. Second, increases in densities of generalist host species favors transmission of vectors and their pathogens. Third, disturbance can also favor generalist vector species, which are important determinants for the spread of zoonotic disease among wildlife populations due to their tendency to feed from a variety of taxa. For this reason, increased abundance of generalist vectors is strongly associated with increased parasite transmission and incidence of disease outbreaks in both human and wildlife population.

The simplification of ecosystems results in a lack of competition, making it easier for pathogens to adapt and thrive. As Vourc’h, Plantard and Morand (2012) note, “...many animal and plant pathogens use a vector to increase gene flow among populations and to reach a new individual host. This genetic diversity is a crucial factor in disease emergence and allows pathogens to adapt to the main selective pressures they face: hosts’ immune systems, the need to be transmitted, and treatments or vaccines used to counter infections” (Vourc’h, Plantard and Morand 2012: 296). Thus, monocrop cultivation is especially vulnerable to disease, which is the reason for the high number of pesticides and insecticides that are needed to attempt to protect these plants. Crop diversity “can reduce

the total burden of disease in agricultural systems” through the “combined effects of (i) the limitation of pathogen dispersal thanks to the physical barriers provided by the presence of non-host plants, (ii) induced systemic resistance, and (iii) competition among pathogens” (Vourc’h, Plantard and Morand 2012: 300) Few crop varieties have limited diversity of genes to depend upon, and thereby have “proven to be ineffective as pathogens manage to overcome resistance” (Vourc’h, Plantard and Morand 2012: 301).

Animal herding also has vulnerabilities to disease. The lack of species variety in livestock, just as crops, limits the potential resistance to pathogens. Accordingly, there is a great connection of livestock and zoonotic disease. Morse *et al.* illustrates this connection:

Almost 50% of the roughly 1000 species of pathogens that are noted in livestock and pets are zoonotic, implying that any barriers between these hosts and human beings are routinely breached by many different pathogens. More than 50% of the recognized pathogens of human beings can infect other vertebrate hosts. (Morse *et al.*, 2012: 1957)

The zoonotic connection people have with their animals and pets have much to do with the close spatial proximity we tend to have with them. However, there is another vulnerability here, in that these animals are more biologically similar to humans than common opportunistic species (i.e. rodents, small mammals) that often carry zoonotic pathogens. Therefore, it can be argued that the adaption for a pathogen is relatively easier to make here than with wild animals, but as Beldomenico and Begon (2010) noted earlier animals in poor health are especially susceptible to zoonotic disease. If that is true then maybe better health of these domesticated animals decreases their risk for zoonotic disease. Additionally, we often give human pathogens to these animals, (which may assist zoonotic pathogens of the livestock to adapt to humans). We are also frequently exposed to livestock zoonotic pathogens through eating their and dairy products (Morse 2012: 1957). As these livestock products become increasingly global, so do the vulnerabilities of zoonoses spanning the globe (Karesh *et al.* 2012: 1939).

1.3 The Defences of an Organism

When disease outbreaks occur in people, the animal source is often difficult to identify, restricting epidemiological investigation and ecological understanding. As for many zoonoses, foodborne pathogens often cause mild or subclinical disease in reservoir hosts, and because surveillance systems for wildlife and domestic animals are not universally adequate for detection of clinical disease or pathogen presence, human beings often act as sentinel populations for zoonoses. (Karesh *et al.* 2012: 1939). An organism with a strong immune system is very effective. A healthy immune system, just as an ecosystem, is diverse, complex and its defences adapt to what is needed to protect the organism, thereby making it difficult for a pathogen to adapt. However, a poor and medicines such as antibiotics may increase this vulnerability, as Karesh *et al.* (2012) illustrate, “Metagenomic studies show that the community of commensal bacteria within healthy hosts plays an important part in defence against pathogens. Furthermore, disruption of this community through changes in diet or use of antimicrobials can allow the growth of other organisms, some of which might be pathogenic” (Karesh *et al.* 2012: 1938). Defence against pathogens is no easy task for immune systems, as they “represent a large part of biodiversity on earth” (Vourc’h, Plantard and Morand 2012: 293). However, a weak immune system does not just pose a risk for that individual, this vulnerable system gives pathogens the opportunity to successfully adapt to others. Vourc’h, Plantard and Morand (2012: 297-298) explain:

An infection also can enhance susceptibility to subsequent infection. In particular, individuals... already...in poor condition may be more susceptible to multiple infections. Furthermore, concomitant infection may allow the exchange of genetic material between strains of a give pathogen species or even between species through horizontal gene transfer, allowing the emergence of new virulent strains.

Immune systems gain antibodies when exposed to a pathogen, thereby effectively fighting off a potential threat to the organism’s health. Weaker immune systems are not able to do that, and are further weakened making the organism especially vulnerable to multiple infections. There are different factors that could limit an immune system’s effectiveness. A couple of these have been

already mentioned: diet, previous exposure to pathogens and how closely they relate to new threats. Another appears to be long-term stress for both humans and wildlife. Brearley *et al.* (2013: 429) explain:

A potential link between human modification of landscapes and disease in wildlife that has received little attention is the effect of increased physiological stress on immune competence. By contrast, major pathways between stress and immune function in humans are well established. Following the perception of a stressor by the brain, the hypothalamus releases corticotropin-releasing hormone (CRH). CRH stimulates the pituitary gland to secrete adrenocorticotrophic hormone (ACTH), which in turn stimulates the adrenal cortex to secrete glucocorticoids (GCs). GC stress hormones (e.g. cortisol or corticosterone in mammals) have been found to inhibit the production and activity of white blood cells. Cortisol also suppresses the capacity of white blood cells to produce chemical messengers, so that different varieties of immune cells become unable to communicate with each other. Cortisol can also signal too many immune cells to stop working.

While predation attempts have been cited to heighten immune system defences, “habitat modification result in reductions of most immune system processes” (Brearley *et al.* 2013: 429). If this is indeed the case, this could mean that wildlife, with weaker immune systems in areas of anthropogenic activity, may be fostering the adaption of pathogens. This adaption process further prepares the pathogens for successful transitions to other organisms as hosts. The host organisms may have been in contact, directly or indirectly with other potential hosts as livestock or humans, thereby potentially passing biological information/pathogens and consequently assisting the pathogen to adapt to the next hosts. Thus, the degree of population divisions of distinct species that potentially carry zoonotic diseases and the context in which these barriers take place are important to consider in assessing the risk of zoonotic infection of human populations and their domestic animals (Wilcox and Colwell 2005: 244-257). The study of socio-economic systems is important to gain greater insight into what leads to plague mortality.

II. Identifying the Environments that a Zoonotic Epidemic Takes Place within

1.4a Defining what constitutes human vulnerability for a zoonotic epidemic

Adger has stated that “Vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt” (Adger 2006). This goes to the heart of the research of infectious disease ecology. Studies over the last couple of decades reveal that vulnerability-factors for human epidemics of zoonotic infectious disease (transmitted from an animal reservoir) include high population densities, human induced changes in the biological make-up of ecological systems and the distinct human interaction within these new ecosystems, intensive herding and farming practices, malnutrition, and prior ill health (See studies of malnutrition and disease in skeletal evidence, i.e. Armelagos, Brown, and Turner 2005; DeWitte and Hughes-Morey. 2008; DeWitte and Hughes-Morey. 2012; DeWitte and Slavin, 2013; Logan 2016; Murphy *et al.* 2013; Power 1985-1986; Power 1993; Power 1994). These ecological factors that help create the context for an epidemic to take place. The vulnerability factors for a human zoonoses (animal transmitted) epidemic identified by McMichael, Laudisoit, and Begon (See Methodology ch. for these factors and explanation behind them) will be used to assess the development of hazards that increase the chances for such an epidemic to occur.

These vulnerability factors offer biological insight for past zoonotic epidemics that may especially be valuable in investigating past Plague outbreaks and the monomorphic pathogen, *Y.pestis*. This pathogen is remarkable in how little it has changed since Black Death, and there is no evidence to show that the 14th century Plague strains were more virulent than those causing modern outbreaks. The ‘Big Bang’ theory of *Y.pestis* mutating into different strains happened sometime before the 14th century pandemic, but little has changed since that time. The ability of the Plague to reappear in the same geographies after long periods, ignited by a series of events is noted in modern outbreaks (Laudisoit 2017 consultation). This also forces the question of when *Y.pestis* actually emerged from its ancestor, and spread to become widely present in Eurasia.

Nevertheless, the basic characteristics of what makes an area vulnerable to an epidemic are consistent over time.

1.4b Socio-Economic Stressors on Ecological Systems

Bausch and Schwarz (2014) observe why the Ebola outbreak started in Guinea and Guéckédou:

But why Guinea and why Guéckédou? Certainly this is not the only place bats migrate [fruit bats are thought to be the reservoir of the Ebola virus]. Unfortunately, Ebola virus outbreaks typically constitute yet another health and economic burden to Africa's most disadvantaged populations. Despite the frequently promulgated image of Ebola virus mysteriously and randomly emerging from the forest, the sites of attack are far from random; large hemorrhagic fever virus outbreaks almost invariably occur in areas in which the economy and public health system have been decimated from years of civil conflict or failed development... Biological and ecological factors may drive emergence of the virus from the forest, but clearly the sociopolitical landscape dictates where it goes from there – and isolated case or two or a large and sustained outbreak. (Bausch and Schwarz 2014: 3-4)

The lack of necessary societal adaption to ecological and economic changes while ecosystem services go into decline may be due to war, societal unrest, or economic (if not full) colonization. War and a high degree of societal instability greatly diminishes the adaptive capacity of a society, as future planning becomes increasingly short-term. The increasing uncertainty of individual's and societal institution's access to resources, communication, transportation, utilities, as well as to what degree various institutions (and labour in general) will be allowed to function, will accordingly lead to increasingly short-term societal and individual priorities.

The loss of local control of resource use can be through direct control of a foreign power or through the economic dependency on foreign markets for cash through cultivating commodities and resource abstraction. Globalisation (defined as a collective of national/economic powers' expansion of trade and economic integration since the European Middle Ages to the present day through socio-

organisational, economic, educational and enculturation institutions that support the large-scale trading economy) may also lead to a nation feeling vulnerable, thereby may 'voluntarily' adhere to larger, more powerful nations demands (i.e. through the G-7, GATT, the World Trade Association, the International Monetary Fund). However, at the same time there is a global awareness of heightened risk, as the World Economic Forum Global Perception Survey 2014 that noted the spread of infectious diseases as second in the Top Ten Risks in terms of impact, after Water Crises (WEF 2015: 12, 59).

The colonial period was instrumental in the expansion of zoonotic infectious diseases. These pathogens were introduced to environments that had no previous history of them, and in these contexts infectious disease epidemics thrived and many people died as a result. Bewell explains the instability and uncertainty of the period.

Of central importance was that different societies were grappling with *new* diseases. Colonialism may not have created new pathogens, but it did bring people who had previously been isolated into contact with each other and with diseases that were new to them. Precolonial peoples inhabited unique disease environments, ecologies that had been built up through the interaction of human beings and microbes over vast spans of time. They would have adapted themselves biologically and culturally to the pathogens around them, and in such circumstances the framing of diseases was largely stable. Diseases that had previously been largely restricted in their geographical ranges, or had slowly made their way to Europe from the East (as had chicken pox, smallpox, and measles), began to travel at epidemic and pandemic speed. The boundaries that historically separated these disease environments were breached as new pathogens were exchanged on a scale far greater than ever before. Traditional physical environments and modes of behaviour were also radically transformed, and these alterations provided opportunities for microbes to colonize new parts of the globe. (Bewell, A. 2003: 3)

The colonial powers impact on the African experience changed dramatically in the 19th century with the intensification of colonial control, which as Kunitz (1996) describes as "upset[ing] what must have been at best an unstable equilibrium." He continues to illustrate the circumstances, "Beyond the possible

introduction of new diseases. European colonisation's acceleration in the 1880s caused a major disruption by forcing large groups of people to work on plantations in areas distant from their homes, usually in unsanitary conditions" (Kunitz 1996: 10). It is during this period that life expectancies were the lowest, estimated as low as the 20s at birth (Cardwell 1981: 463). However, these colonial powers had centuries of experience in dealing with problems of overexploitation of resources, labour and infectious disease and had some success in augmenting lifespans in later decades, especially regarding Europeans living in colonial lands. Though the majority of native Africans were systematically largely left out of many health care measures (Cardwell 1981: 47-486). The spreading of zoonotic infections made it easier for colonial dominance, while resources continued to flow in at an unsustainable rate.

As Bewell (2003) illustrates above, before European conquests around the world, people were much more tied to the ecologies they depended upon and they were much less likely to migrate to new ecologies or have much contact with those who had. This economic expansionism around the world in order to harvest enormous quantities of resources was having a dramatic effect on the global landscapes, as many Europeans witnessed "new" 'Gardens of Eden' from around the world that looked far removed from the over-exploited Europe.

Braudel (1982: 69-70) exemplifies this experience in stating,

...even at the end of the eighteenth century, vast areas of the earth were still a garden of Eden for animal life. Man's intrusion upon these paradises was a tragic innovation...what was shattered in both China and Europe with the eighteenth century was a biological Ancien Régime, a set of restrictions, obstacles, structures and numerical relationships that hitherto had been the norm.

The environments that people lived in had encouraged them to leave the continent as pollution, contamination, over-exploited resources and labour, malnutrition and disease led to much shorter lifespans than was seen previous to the Middle Ages (DeWitte, and Hughes-Morey. 2008: 1436-1441; DeWitte, and Hughes-Morey. 2012: 1412-1419). Even as early as the late twelfth century,

Giraldus Cambrensis (1982: 34-35) observed the distinct difference of living in the European frontier land of Ireland from England in stating that

The grass is green in the fields in winter just the same in summer. Consequently the meadows are not cut for fodder, nor do they every build stalls for their beasts. The country enjoys the freshness and mildness of spring almost all year round. The air is so healthy that there is no disease-bearing cloud, or pestilential vapor, or corrupting breeze. This island has little use of doctors... anyone born here, who has never left its healthy soil and air, if he be of the native people never suffers from any of the three kinds of fevers...(Cambrensis 1982: 34-35)

This picture of the garden of Eden in early medieval Europe was not to last, as a bit over a century later indicated by skeletal analysis in some graveyards frequently showed evidence of malnutrition and disease and the average age estimated as low as the mid-20s (Power 1994: 95-118; Power 1985: 49-53), whereas millennia earlier the average age was 71 (Power 1993: 9-17). Although there was not much to exploit from over-exploited European lands, the same unsustainable practices continued by being exported to other territories. However, these colonial powers had centuries of experience in dealing with health problems and had some success in doing so, especially regarding Europeans living in colonial lands. The spreading of zoonotic infections made it easier for colonial dominance, while resources continued to be exploited at an unsustainable rate.

Many national boundaries today are much larger than pre-colonial times, as a result of the European invasion and governing of these lands that put people together with people using different languages, cultural geographies, economies, and traditions. The political boundaries were just made on the basis of the extent the coloniser's ability to expand their territory in order to maximize their resource allocation. This has led to people's diminished tie to the lands they survive on. These types of circumstances certainly diminish a country's ability to adapt and take measures for the best interest for its citizens in the long-term interests and the nation's sustainability culturally, economically, ecologically, and politically. However, this is not just a phenomenon of the last few centuries,

but may indeed be a fundamental indicator of heightened risk for a zoonotic epidemic in more ancient zoonotic epidemics.

III. The Background of the Plague Pandemics and the Historical Narrative of Black Death

1.5 Human Societies, the Emergence of Zoonotic Disease and the Three Plague Pandemics

Zoonotic epidemics may be a symptom of unsustainable socio-economic systems and institutions as humanity becomes increasingly separated from the natural world and the ecological systems that we ultimately depend on. The majority of emerging infectious disease are zoonotic (Jones *et al* 2008: 990-993) and as Hassell *et al.* (2017:55) state, “it is the anthropogenic influence on ecological systems that dictates the level of risk that operates at the interface between humans and animals in zoonotic disease emergence.” Therefore, there is concern within the field of infectious disease ecology regarding what will be the consequence of the continued expansion of human dominated landscapes on the spatial and temporal distribution of wildlife and their interactions with parasites and pathogens (Becker, Streicker, & Altizer 2015:493).

Parasitic life is more dependent upon humans than any other animal species.³ This may in large part be due to our way of life.⁴ Krause (2016) observed that when people became sedentary with the domestication of large animal herds, people’s risk from the many pathogens these animals carry escalated. The development of sedentary agrarian societies led to the rise of large-scale networks⁵ and the expansion of cultivation and animal husbandry.

As these societies grew, so too did the risk of a wider scale epidemic or pandemic, as was the case for the Justinian Plague and Black Death. The Justinian Plague that occurred at the end of the Roman Empire was first recorded in present-day Egypt and later across southern Europe while the next occurrence of bubonic plague was largely across Europe, Western Asia and the

eastern Mediterranean in the mid-14th century. Subsequent outbreaks occurred periodically after both these epidemics, as is common for more modern outbreaks in sub-Saharan Africa, China and India. The later, also known as the third Pandemic, started in China and continued to spread from there. *Yersinia pestis* has been identified as the causal agent for all three of these pandemics (Krause 2016).

1.6 Foundation of our Historical Narrative of Black Death

The 1890s were a key period in Black Death research that set a precedent for later historical studies. There were two key influential works that transformed this research, first with Yesernia discovering that a bacterium, *Yesernia Pestis*, was causing the Bubonic Plague outbreak in India and abruptly afterwards Gasquet published *The Great Pestilence* on the spread of the Bubonic Plague as the cause of Black Death. Recently DNA evidence from medieval graves has shown that *Y.pestis* was indeed present in some bodies from the mid-14th century (DeWitte and Wood ,2008; Haensch *et al.*, 2010; Bos *et al.*, 2010). Thus, we do know that at the very least *Y.pestis* played a role and may have been the dominant pathogen that caused such an epidemic. Gasquet set the foundation that research of Black Death has followed ever since. This rapid transformation of historical research may have been with a lack of critique as Pobst (2013:809) observes,

The Great Pestilence (1893) by... F. A. Gasquet, who adopted the bubonic plague diagnosis when it was brand new. In the second edition, Gasquet noted that, thanks to health authorities in India, much more was known about “the great epidemic of the fourteenth century, now commonly known as “The Black Death,”Gasquet had considerable influence, and other historians also quickly embraced this idea as fact.

There are problems with the Gasquet’s account in India and transferring the analysis of the situation to 14th century Europe, which was of a distinct genome strain of *Y.pestis*. First of all, India’s epidemics tended to be felt in the vicinities in and around villages rather than urban areas. Hankin (1905) investigated the plague at the end of the nineteenth century and compared where the geographic characteristics of past outbreaks with the contemporary epidemic, which resulted in the following observation,

On referring to records of the plague outbreak in Western India in 1812, it appears that, so far as the evidence goes, it resembled the present Indian plague, both in its avoidance of trade routes as such, and in its great virulence in villages as compared with towns, during the first eight years of its existence'. It was only at about the end of this period that it showed itself as a virulent disease in a comparatively large town (Ahmedabad). Another plague having similar characters also occurred in Western India, namely, the Pali plague of 1836. Though this produced a high mortality in the small town of Pali, it appears to have been more destructive in the surrounding country, where in spite of the smallness of the area affected, it is variously estimated to have destroyed from 60,000 to 100,000 persons. Pali was then an important trade centre, yet the disease failed to spread along any trade routes from this town. (Hankin, 1905:57)

Hankin observes a higher death rate in the villages instead of urban areas, which only became infected with the Plague as secondary outbreak areas. The chart below shows Kale, a village of 4,431 as having the highest death rate. However, Hankin makes a point that these geographic areas also need to be analysed, as he did in the case of Bombay. Hankin explains that the "death rate in Bombay is derived from the lower plague death rates from crowded and less sanitary central portions of the city, and higher plague death rates in suburban districts where the village conditions prevailed" (Hankin, 1905:56). Hankin's further investigation illustrates a potential characteristic that his chart of a sample of the Plague death rate in municipal areas alone may be difficult to see much of a correlation.

Table 1.2. Hankin's (1905:56) table of selected municipalities death rate from the late 19th century Plague in India.

Name of place	Number of inhabitants	Death rate from plague per 1000 inhabitants
Bombay	806,144	20·1
Poona	161,696	31·2
Karachi	97,009	24·1
Sholapur	61,564	35·0
Kale	4,431	104·9
Supne	2,068	102·5
Ibrampur	1,692	360·5

This late nineteenth century plague (as well as subsequent early twentieth

century plague outbreaks) (<https://www.cdc.gov/plague/history/index.html>) took place when over-exploitation of resources was proceeding at a more rapid rate, through deforestation, agriculture and animal husbandry (Dangwal, 2005:110-124). The introduction of English shorthorned cattle led to feed shortages and overstocking as the breed was especially vulnerable to tropical diseases (Roy, 2006:5395). In the second half of the nineteenth century, agricultural exports began to grow tremendously and land degradation followed as deforestation (Guha, 1983:1885), agriculture and animal husbandry increased in territory and intensity (Roy, 2006:5395). The railways expanded rapidly in this period in order to transport resources cost-effectively (Guha, 1983: 1883) (Fig.3). The revenue from lumber continued to grow in the second half of the nineteenth century (Guha 1983:1885), while also clearing more lands for agriculture. This was happening while the dependency upon cash-crop agriculture was increasing, while wages were gradually falling (Clingingsmith and Williamson, 2008: 2120) (Fig.5). Famine followed in the late 19th century, with some rivers “drying up”. Increased silt deposits and standing water led to increased problems with malaria (Roy, 2006:5393-5394).

Table 1.3. Railway Expansion in India from 1853 to 1910: Guha (1983: 1883) based from data from the Government of India, "History of Indian Railways"(1964: 214) shows the dramatic increase of railway lines across India from 1853 to 1910.

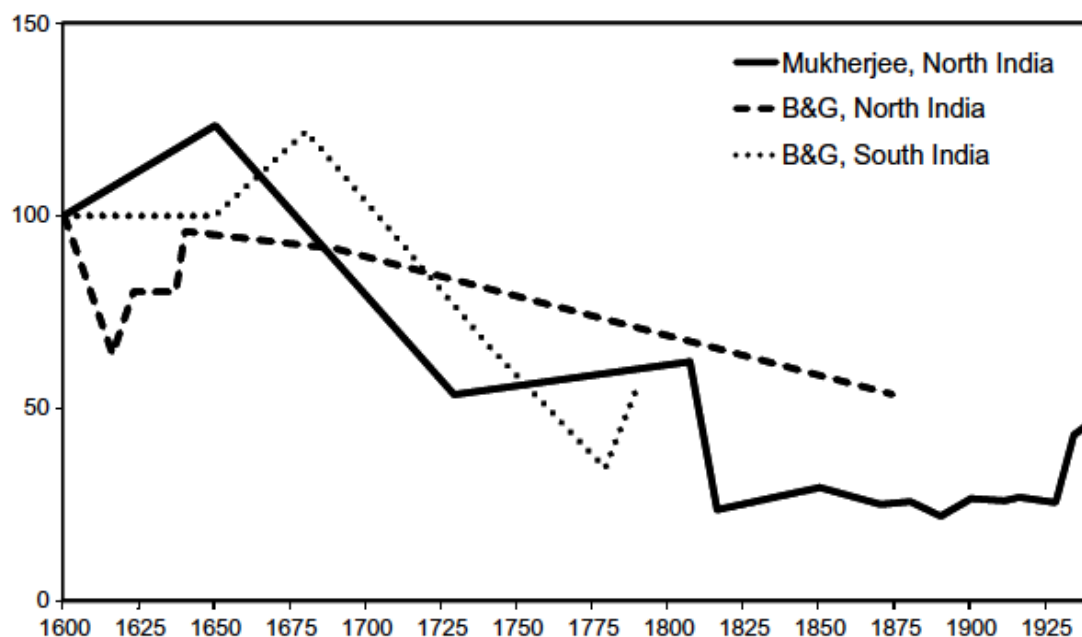
Year	Kilo-metrage	Outlay (Rs million)	Net earnings (Rs million)
1853	32	3.8	0.05
1860	1,349	266.6	3.0
1870	7,678	900.0	30.3
1880	14,745	1,285.7	63.9
1890	26,395	2,136.7	103.6
1900	39,834	3,296.1	164.5
1910	51,658	4,390.5	239.9

Table 1.4. Revenue and Surplus in Millions of Indian Rupees of the Forest Department from 1869 to 1925 : Guha (1983:1885) based from Stebbing III's *The Forests of India* (3 volumes, 1922-27) table illustrates the rapid increase in lumber revenue from 1869 to 1925 of the Forest Department.

Yearly Average for the Period	Revenue (Rs million)	Surplus (Rs million)	Percentage of Column 3 to Column 2
(1)	(2)	(3)	(4)
1869-70 to 1873-74	5.6	1.7	30
1874-75 to 1878-79	6.7	2.1	31
1879-80 to 1883-84	8.8	3.2	36
1884-85 to 1888-89	11.7	4.2	36
1889-90 to 1893-94	15.9	7.3	46
1894-95 to 1898-99	17.7	7.9	45
1899-1900 to 1903-04	19.7	8.4	43
1904-05 to 1908-09	25.7	11.6	45
1909-10 to 1913-14	29.6	13.2	45
1914-15 to 1918-19	37.1	16.0	43
1919-20 to 1923-24	55.2	18.5	34
1924 to 1925	56.7	21.3	38

Fig.1.1 Wages for Indian Labourers of the East India Company in Terms of Grain Purchasing Power (1600-1925)

Clingingsmith & Williamson (2008:212) Chart the grain wages (the nominal wage divided by the price of textiles) in India from 1600 to 1938.



Was the intensification of agriculture, animal husbandry, and forestry leading to famine also linked to the increased presence of diseases as malaria, and the plague? The greater risk in deforested agricultural settlement areas, in fact, reflects observable characteristics of modern Plague (See Begon's, McMichael's, and Laudisoit's vulnerability factors for human zoonotic epidemics, pp.28-29). The European historical record, however, focuses on urban outbreaks as well as outbreaks in monasteries, but this may be due to the fact that these were centres where publishing took place. The Eastern Mediterranean, has accounts of the Plague devastating cash crop areas:

(Depopulation)...appears to have been even more severe in Upper Egypt, where plague seized the people from the end of 749/February 1349. The upper Nile Valley was virtually deserted, despite the vast area of normally cultivated lands. In the region of Asyūt, the land tax was customarily gathered from about 6,000 people, but during the Black Death the tax was collected from only 116. Some areas, such as Aswān (which was known for trade but not regional agriculture), were lightly affected; only eleven deaths were counted...We are told that the Black Death similarly bypassed the Syrian towns of Ma'arrat an-Nu'mān, Shayzar, and al-Hārim. However, in most Upper Egypt, e.g., Bahjūrah and Akhmīm, the Black Death was quite serious. In the year 1389, out of 24,000 *faddans* (1 faddan \approx approx.. 1.35 acres) of productive lands in Luxor, only 1,000 were being cultivated. (Dols 1977:161)

What is also interesting is that there are multiple accounts of people fleeing the rural agricultural areas to the perceived safety of cities as seen in the Tahsīl's contemporary account, here paraphrased by Dols,

The diminished number of peasants was due to flight from the land, as well as to plague mortality. Everywhere plague occurred, there is evidence of flight from the countryside. Even in the Arabic accounts of Andalusia, the rural laborers are reported to have fled to the cities when the plague struck their villages. (Dols, 1977, 162)

Our entrenchment of Gasquet's view of Bubonic Plague being an urban disease does not seem to be on solid biological ground either in the 19th century epidemic in India (the third Plague clade) or the mid-14th in the Europe and the Malmuk Empire (the second Plague clade) and certainly deserves to be questioned further. This argument was questioned by Shrewberry's work *A History of Bubonic Plague in the British Isles* (1970), which also acknowledged

that the plague that would disappear and re-appear in the same place seems to be more in line with the biological evidence and the genome map of *Y.pestis*. Regarding the transplanting the 19th century Plague in India to mid-14th century Europe, there have been some discoveries that have proved the traditional narrative since Gasquet to be flawed. First, India being largely a tropical and subtropical country supports the ideal climate for the black rat, a rodent that nests in trees, but a “host” of studies of *Y.pestis* has shown over a hundred animals have been tested positive for the pathogen. It is also interesting that the second strain outbreaks in Africa and the Americas have largely happened in higher altitudes that are too cool for the black rat to thrive (Eisen, *et al.* 2007:530-537). Additionally, not only fleas but also lice from different animals (including humans) have been found to carry *Y.pestis* (Ayyadurai *et al.* 2010; Houhamdi and Raoult 2006; Piarroux *et al.* 2013). There is also a pneumonic form of the disease that would lead to other ways to contract the disease through direct and indirect contact as well as the bacterium being airborne (after an infected person coughed).

Gasquet’s and most other subsequent historical narratives have largely not addressed the means by which *Y.pestis* can survive in an environment even when no outbreaks of the Plague have occurred for years, commonly decades. *Y.pestis* has been found to successfully live in some soils for over 40 weeks (Ayyadurai *et al.* 2010; Houhamdi and Raoult 2006; Piarroux *et al.* 2013), as well as living within some animal populations, including rodents, during such periods (Eisen and Gage 2009). The Plague has a long history of re-occurrences up to the modern day, but this phenomenon is rarely discussed in historical scholarship. Additionally, as an increasing amount of evidence has been uncovered demonstrating that *Y.pestis* is not an especially virulent or contagious pathogen, the mainstream historical narrative has concluded that *Y.pestis* of Black Death must have been exceptionally virulent and contagious strain that is distinct from more recent outbreaks. However, there has not been *any* biological evidence to support this position. The genome map of *Y.pestis* is strong evidence against this position showing that many modern outbreaks involve the same strain which spread during Black Death (Bos *et al.*, 2011:506-511; Cui *et al.*, 2013: 577-582;

DeWitte *et al.*, 2008:1436-1441; Green, 2014:1).

In order to contest the Gasquet narrative, this work will be based on the genomic evidence of *Y.pestis*, as well as its adaptability, characteristics, and the context of Black Death. The analysis will take account of observed vulnerability factors for zoonotic epidemics that disproportionately put some people at risk of falling ill from plague (McMichael, 2004: 1049-1058; Begon, 2013 consultation).

1.7 Defining what is the Plague

According to the World Health Organisation, “People infected with plague usually develop “flu-like” symptoms after an incubation period of 3-7 days. Typical symptoms are the sudden onset of fever, chills, head and body-aches and weakness, vomiting and nausea.” There are three types of Plague, bubonic, septicaemic and pneumonic. Those that contract bubonic plague may also develop inflamed lymph nodes “bubos” in the advanced stages, which may become open sores. Septicaemic plague spreads through the bloodstream, which may be spread through the bites of blood feeding insects and direct contact with that which has been infected with the bacteria, *Yersinia pestis*, that has access to an individual’s bloodstream, i.e. through cracked skin. Pneumonic plague that may occur in the most advanced stages of bubonic plague, which turns into a lung infection, is the least common, but most lethal form of plague. This type is commonly spread from person to person. Bubonic Plague is more likely to occur in rural areas that altered the landscape and ecological systems to satisfy the demand of the urban, trade-based economy, whereas the later development of Pneumonic Plague depends upon people being in very close proximity to each other for it to spread, that is rare but is more common in more densely populated urban areas (Tsuzuki *et al.* 2017:5).

It should also be noted that the *bubos*, which are the most publicised characteristics of bubonic plague are seen in a minority of modern day cases, though these symptoms would increase as the severity intensifies. However, the rapid onset of an intense fever would be the main symptom that would require a person to be tested for the disease with a blood test.

When speaking of the pandemic, Black Death of the mid-14th century, it is commonly asserted that it was simply a Plague pandemic. However that would be an oversimplification that is important to address as people that are suffering from another infection have shown greater vulnerability to become infected with zoonotic diseases as the Plague (Beldomenico & Begon 2010:21-27), while DeWitte has illustrated that the skeletal evidence of plague victims of the medieval pandemic disproportionately showing signs of malnutrition and evidence of previous disease infections compared to those that survived (DeWitte & Hughes-Morey 2012: 1412-1419; DeWitte & Slavin 2013:37-60; DeWitte & Wood 2008: 1436-1441).

IV. Health and Environment prior to Black Death: Nutrition/Malnutrition, Illness, and Disease in the late 13th to the mid-14th century

1.8 Cereals, Toxins, and Vulnerability to Disease

The development of wealth necessitates a surplus of food to maintain specialist soldiers, craftsmen, traders, administrators, lawyers, scribes, etc. Thus, low-cost, large-scale agricultural production is fostered to meet the caloric needs of the people. This has been done through the cultivation of cereals. However, there are some vulnerabilities here, including a greater risk of disease. Percaica *et al.* in a World Health Organization publication illustrate this anciently acknowledged risk:

The untoward effect of moulds and fungi was known already in ancient times. In the seventh and eighth centuries BC the festival "Robigalia" was established to honour the god Robigus, who had to be propitiated in order to protect grain and trees. It was celebrated on 25 April because that was the most likely time for crops to be attacked by rust or mildew (Percaica, Radic, Lucic and Pavlovic 1999: 754).

Mycotoxins as Ergot, was a well-known cause of disease of the Greeks and Romans had become a serious and widespread illness in the Middle Ages. As the Church and different secular powers were gaining wealth, so were there perceived threats of other secular and religious institutions (both Christian and Muslim). Therefore, the dependency upon cereal production increased as war

and the threat of war also increased. Poisoning from Ergot in western Europe became a greater concern from the late 11th century. Hospitals were set up for the disease. Graham describes this development:

A few years after the arrival of the Benedictines, St. Antoine became a famous place of pilgrimage, particularly for sufferers from a dreadful disease known to the Greeks and to the Romans, who called it 'ignis sacer'; in the Middle Ages it was called first the infernal fire and then St. Anthony's fire on account of the cures at then St. Anthony's fire on account of the cures at St. Antoine. St. Anthony's fire was not as has sometimes been said, a pestilential erysipelas; it was ergotism, an epidemic caused by the mixture of grains in rye which have been poisoned by a parasite known as 'claviceps purpurea.' In France there were six great outbreaks in the tenth century, seven in the eleventh, ten in the twelfth, and three in the thirteenth century (Graham 1927: 342.).

Subsequent researchers have included the first half of the fourteenth century as part of the large-scale Ergot and/or other types of Mycotoxins outbreaks (Lee 2009:179-84; Byryden 2007: 95-101; Wong 1951; Matossian 1991). Ergot and other mycotoxins are thought to tax and/or suppress the immune system, as well as lead to dangerous symptoms that often are life-threatening. The awareness and prevalence of ergot-caused disease can be seen as the dependence of cereal production was rapidly escalating in early in the 12th century, as St. Antoine quickly became a pilgrimage site. Lee explains two distinct set of symptoms of Ergot:

Although this fungus is recognized as one species, there are two sets of symptoms that can be found in cases where serious poisoning as occurred: **convulsive** and **gangrenous ergotism**.

Convulsive ergotism is characterized by nervous dysfunction, where the victim is twisting and contorting their body in pain, trembling and shaking, and wryneck, a more or less fixed twisting of the neck, which seems to simulate convulsions or fits. In some cases, this is accompanied by muscle spasms, confusions, delusions and hallucinations, as well as a number of other symptoms.

In gangrenous ergotism, the victim may lose parts of their extremities, such as toes, fingers, ear lobes or in more serious cases, arms and legs may be lost. This type of ergotism causes gangrene to occur by constricting the blood vessels leading to the extremities. Because of the decrease in blood flow, infections occur in the extremities, accompanied by burning pain. Once gangrene has occurred, the fingers, toes, etc. become mummified, and will eventually fall off as a result of infection. If the infected extremities are not removed, infection can spread further up the extremity that has been infected. Gangrenous ergotism is common in grazing, farm animals (Lee 2009: 179-84).

This disease is spread through fungus that grows on certain grains, especially rye, but can be found on other grains, as wheat. Since the peasantry depended upon cereals for their diet, they would seem to be at the greatest risk. The pilgrimage site where those that suffered from ergot would receive food, drink and care from the Order of Hospitallers of St. Antoine-de-Viennos is interesting because as Graham notes below, these ill people were given wine. This may be a signal to the diminished dependency upon cereals at the site, and pilgrims may have received nutrients that their immune systems desperately needed, which may have led to the recovery of some (Graham 1927:243).⁶

The susceptibility of being poisoned by ergot goes beyond the direct consumption of the infected cereals. The milk of affected breastfeeding mothers and domesticated animals can pass on the toxins (Matossian 1991:9). Additionally, studies of a number of mycotoxins show exposure in utero risked birth defects and impaired embryonic development (Byryden 2007: 96).

⁶ For more specific medical information on specific mycotoxins see Percaica, Radic, Lucic and Pavlovic. 1999: 754.

In the Middle Ages, outbreaks of ergotism caused by ergot alkaloids from *Claviceps purpurea* reached epidemic proportions, mutilating and killing thousands of people in Europe. Ergotism was also known as *ignis sacer* (sacred fire) or St Anthony's fire, because at the time it was thought that a pilgrimage to the shrine of St Anthony would bring relief from the intense burning sensation experienced. The victims of ergotism were exposed to lysergic acid diethylamide (LSD), a hallucinogen, produced during the baking of bread made with ergot-contaminated wheat, as well as to other ergot toxins and hallucinogens, as well as belladonna alkaloids from mandragora apple, which was used to treat ergotism.

Matossian explains other reproductive risks in *Poisons of the Past: Molds, Epidemics, and History*, "Various chemicals which constitute ergot interfere with the re-production of humans and domestic animals. Ergonovine may act as an abortifacient, and other alkaloids suppress fertility or stop lactation" (Matossian 1991: 9). This may be interesting in the later fourteenth century, as possibly one reason why the population did not rebound quickly was due to problems of infertility. Furthermore, mycotoxins found in cereals have been traced to high rates of liver cancer as well as other diseases (see footnotes below).⁷ The health vulnerabilities related to mycotoxins in cereals, which were common in the late middle ages, raise the question if they contributed to Black Death in the mid-14th century. Matossian observes:

...(Was) the death rate (of Black Death)...so high because of the virulence of the infectious agent alone, or if the ability of the human body to fend off disease was impaired in some way(?)...There is no experimental evidence linking the occurrence of plague with immunosuppression in humans, but it is well known that the case mortality rate from plague may vary widely in neighboring communities. In twentieth-century Russia, for example, it was 96.2 percent in Astrakhan province (1909-1910) and only 26.7 percent in Odessa (1910). We must consider whether immunosuppressant mycotoxins in grain could account for these differences. (Matossian 1991: 48; cf. Matossian 1986)

The taxing and overall health of the immune systems is not something that is often looked at when analyzing epidemics of the past. However, it is basic knowledge that malnutrition, illness and other diseases are known to lower the effectiveness of immune systems. During the Black Death of the mid-14th century the wealthy class were much less impacted. A Bruce McFarlane survey of English lords and high clergy was only 13% (inclusive of all causes of death),

⁷ Byrden 2007: 95. Deoxynivalenol (DON) is the trichothecene most often encountered in the field. Fumonisin and aflatoxin B1 consumption contributes significantly to the high incidence of human liver cancer in many developing countries, especially in individuals infected with hepatitis B or C virus. Ochratoxin A is nephrotoxic and a possible cause of urinary tract tumors and Balkan – endemic nephropathy. There are a number of other mycotoxins that cause disease and these include zearalenone (*Fusarium*), an oestrogenic mycotoxin and ergot alkaloids produced on cereal grains (*Claviceps*) or by endophytic fungi (*Neophytodium*). The mechanism(s) of action of these mycotoxins is generally well characterised.

which was significantly less than half than the national rate (though this rate did increase after the subsequent peasant labour shortage in 1361 to 23.9%) (McFarlane 1973:168-1710. Additionally, there is no convincing evidence that any European kings died of Black Death. The wealthy had more varied diets, which were richer in meats that provide amino acids that are so essential for healthy immune systems (Cordain *et al* 2005:341-354; Cordain *et al* 2000; DeWitte & Hughes-Morey 2012: 1412-1419; DeWitte & Slavin 2013:37-60; DeWitte & Wood 2008:1436-1441; Marcinkiewicz, & Kontny 2014: 7-20; Randolph *et al.* 2007: 2788-2800; Williams 2007). Since, no plant-based food provides all the necessary amino acids, a great variety would have been needed to account for the most essential ones, which does not appear to be a focus during the period, especially on manor lands where cash-crops dominated. Therefore, meat availability shows the divide between the wealthy and the peasantry that very well may have been an important factor in people's health. Ervynck illustrates the variety of sources of meat that would have been consumed by the medieval elite:

...rich kitchens of lay or clerical lords were "characterized by a high species variety, a selection for the best meat parts of a carcass, the abundance of the remains of young animals and the presence of game and rare and/or expensive species. Flemish castle dwellers were especially fond of port and the meat of wild animals, both mammals and birds in great variety, while monastic tables carried little pork or game but many, often large or rare, fishes, fowl, and occasional beef or mutton." (Ervynck 1997: 78)

The medieval elites, as all classes, were economically dependent upon cereal production, but their diet was much less so, as wealth allowed the purchase of different foods and their privately owned domesticated animals, forests, and ponds typically provided a more than ample food supply. These different outlets for animal protein may have improved immune system function and diminished vulnerability to malnourishment and mycotoxins. A cereal-rich diet increased exposure to mycotoxins but in recent times more rigorous hygiene standards have diminished this problem (Percaica, Radic, Lucic and Pavlovic 1999:754). Nevertheless, Bryden illustrates continuing problems in, *Mycotoxins in the Food Chain: Human Health Implications*:

In many regions of the world, dietary staples, especially cereal grains contain low levels of mycotoxins. The impact of regular low level intake of mycotoxins on human health is likely to be significant with a number of possible consequences including impaired growth and development, immune dysfunction and the disease consequences of alterations in DNA metabolism...

In many African countries the mycotoxin problem is related to insufficient food and the reliance on a single crop (eg. maize). In these situations, with high daily intake of the cereal, only moderate mycotoxin contamination levels are required to exceed recommended tolerable intake for mycotoxins. (Byryden 2007: 96)

The risk of food poisoning during medieval times would have been much greater than today, especially with the increased reliance to cereal production without sufficient food alternatives. However, inexpensive food production was key to building a larger economic and military power. This agenda was followed by the Frankish leaders in remembering the earlier success of their Mediterranean neighbours. The dependency upon cereals continued to expand across Western Europe and across the English Channel, particularly after the Norman invasion. Hoffman explains:

Frankish rulers actively promoted cereal consumption and cultivation long before the pressures of general population growth would force people to capture the larger share of biological production available from eating more plants (see the trophic pyramid). Subsequently, of course, the number of poor peasants dependent on cheap calories grew in tandem with concentration on grain farming — to the extreme of the cereal monoculture established in the English Midlands under pressure of late Anglo-Saxon population increases and comparable conditions in some parts of the continent. By around 1200, the inhabitants of central Europe were getting twice the proportion of their calories from grain as had their early medieval ancestors. (Hoffmann 2008: 25)

Ergot and mycotoxins, as noted earlier, thrive under certain conditions. Percaica *et al.* explain, “Mycotoxicoses ... arise when environmental, social and economic conditions combine with meteorological conditions (humidity, temperature) which favour the growth of moulds” (Percaica, Radic, Lucic and Pavlovic 1999: 755). Matossian describes these meteorological conditions more specifically to rye, which has been thought to be especially present in medieval

Europe (Lee 2009: 179-84; Wong 1951; Matossian 1991) by noting, “a cloudy and wet spring, which lengthened the time the rye flowers were open and hence vulnerable to infection (ergot spores “take root” in the rye flower). Maximum alkaloid production occurred when air temperature was between 17.4 and 18.9 C” (Matossian 1991: 14). Certainly cloudy and wet weather with moderately warm temperatures would be common in Irish summers, while somewhat cooler and wet springs and autumns and mild winters would be the norm. Matossian also describes the expansion of cultivated areas and the planting of winter rye as increasing the chances for the development of Ergot:

Also favorable for ergot infection was the presence of ergot-infected grasses growing wild in nearby areas. This was more likely to be the case when the land was newly cultivated. Low, shady, marshy land provided more water for growth of *Caviceps purpurea*. Soils that were not deeply plowed permitted the sclerotia to germinate and form spores in the spring. Winter rye was more likely to be infected than spring rye.

In a community that grew both rye and wheat, consumption of rye was likely to increase after a severe winter, for winter rye, planted in the fall, was more likely to survive than winter wheat. But after a severe winter, rye was likely to contain more ergot than usual. (Matossian 1991: 14)

Milder and wetter climates are not only associated with mycotoxins, but also the bubonic plague MacMillan *et al.* 2012: 514., while wetter areas in general have been considered a risk factor for an epidemic (Eisen and Gage 2012; McMichael 2004). For instance, recent bubonic plague epidemics in sub-Saharan Africa (where most occurrences plague cases have occurred in the last few decades) has been typically found above 1300 meters, which sees mild temperatures, “and was positively associated with indices of wetness and bare soil during the dry season. The predictive variables were presumed to be associated with growth of annual agricultural crops” (MacMillan *et al.* 2012: 514). Eisen and Gage in attempting to gather risk factors to model risk of the plague and other epizootic activity observed:

Spatial and temporal distributions of plague are often associated with temperature and rainfall patterns. Worldwide, more than 95% of plague cases are reported from areas with average temperatures that exceed 13°C...increased moisture levels prior to a transmission season are

typically favorable for epizootic activity, whereas elevated temperatures during the transmission season are often unfavourable (above 27 degrees C). (Eisen and Gage 2012: 64)

Interestingly, these modern observations seem to also fit well with corresponding climatic and environmental information leading up to Black Death. Biraben illustrates:

We have found innumerable examples where rain has provoked a recrudescence of the plague, beginning with the year 1348, which is mentioned by the chroniclers as very rainy and humid in Mediterranean regions...We have never found a contrary example, where the plague ceased following rains...All the causes of dryness stop the plague, and we can cite many examples. (Biraben 1975: 50)

It should also be noted that Europe had been suffering from low crop yields and famine (i.e. The Great Famine of 1315-1318, the wide-spread crop failures in the 1320s and 1330s, as well as the great cattle murrain that dramatically diminished the cattle population and lasted until the 1320s) (Slavin 2011:1250), which would have led to a heightened vulnerability of malnutrition, greater cultivation of rye (the heartiest grain that can grow in soils of a nutrient level that would not sustain other cereals). Additionally, the incentive to eat grain that might have been infected with ergot or other mycotoxins would have been increased. These poisons are not easy to eradicate, as Matossian notes, "Ergotism epidemics could occur at any time because ergot alkaloids are very stable and may retain their toxicity for up to eighteen months. They do not break down during baking at low heat or boiling up to three hours" (Matossian 1991: 14). Additionally, the wetness of the period may have not been all due to the weather. Deforestation, which is well known to have increased in this period certainly would have increased the ground moisture, and continual ploughing over time, as mentioned in earlier chapters, also may have contributed to increase wetness over cultivated areas, leaching the soils, thereby over-hydrating the grain crops.

1.9 Grain Storage and the Risk of Toxicity

The vulnerability of grains developing moulds that produce ergot and other mycotoxins is not limited to while they are growing.

In the pre-harvest period, crops that have experienced significant stress whether it be from drought or insects can succumb to fungal invasion... During the post-harvest period, control of moisture and temperature of the stored commodity will largely determine the degree of fungal activity.(Byryden 2007: 96)

The storage of grain is very necessary for the accumulation of wealth, as significant amounts would be gathered before investing in shipping costs. However, these grain storage areas could have turned into ideal fermentation grounds for both the plague and mycotoxins. Motossian describes a possible scenario:

Plague tended to appear where there were surpluses of grain—and, because grain is the rat's favorite food, a "surplus" of rats. Along with their hosts, rat fleas also thrive in cereal debris, a suitable pabulum for their larvae. Stored grain surpluses tended to be found in commercial areas, such as southeastern England and along the Rhine and the Rhône rivers. The medieval population was heavily dependent on cereals. All small grains, including wheat (the staple of the Levant) and rye (the staple of European commoners north of the Alps and Pyrenees and east into Russia), can serve as substrates for mycotoxin formation. (Matossian 1991: 50)

Rodents and other opportunistic species that are "domesticated" to live close to human habitats also increase the potential for a zoonotic disease to be transmitted to humans. The large storage of food and the simplification of the environment through deforestation and larger-scale agriculture diminishes the amount of ecological niches available that many species need to survive while the opportunistic species are able to generalize and take advantage of food sources from multiple sources. Therefore, these species may experience a population boom, since they are able to adapt to the large food source available while actually having a decrease in the amount of predators. However, there is more that is being held in the ecological balance:

New arable fields created a new ecological niche, where humans captured a larger share of primary biological production. For the sake of those plants which medieval European herbivores wanted to eat, humans replaced old natural ecosystems with low productivity relative to high biomass of long-

lived organisms (namely, trees) with an artificial agroecosystem containing a lower biomass of short-lived pioneer plants. High diversity of producing and consuming organisms gave way to low diversity, ideally a monoculture of annual cereal grasses, and to a short food chain, namely, some domestic herbivores and many, mainly plant eating, humans. Such ecosystems with low diversity of short-lived organisms and truncated food chains are characteristically unstable. They require continual inputs of energy to keep them at the pioneer stage, by preventing ecological succession of longer-lived woody plants. Intensive cereal growing demanded more human labor and more natural plant nutrients throughout the annual production cycle than had earlier, more loosely mixed forms of agropastoralism. (Hoffmann 2008: 26)

Ecological instability results in food insecurity. Malnutrition weakens the immune system and increases the risk of an illness or disease becoming serious and potentially fatal. Evidence for this as a potential factor can be seen with the increase in meat consumption (which provides amino acids that support immune systems) and the decrease in the death rate during subsequent epidemics in the late 14th century and beyond (Hoffmann 2008:24). The dependency upon an unsustainable ecological system helped create the demand for new lands to be taken over and cultivated. From the eleventh century, especially from the start of the Crusades, the short-term need for wealth and cereal production out-weighted concerns for ecological sustainability, as the medieval economy was increasingly based on trade. However, the medieval trading economy was having a dramatic effect on the ecosystems the people were ultimately tied to:

The new medieval agroecosystem disturbed the balance between plant cover, soil, and nutrients. Colonization on new lands and intensification on old lands initiated and accelerated large-scale soil erosion and deposition, which even led to the formation of new landscapes at some distance from the sites of human intervention. Broken vegetative cover, coupled with soil and nutrient loss, exposed large expanses of soil surface for seasonal removal, more often by water than by wind, and subsequent deposition. Bottom cores from the Lac d'Annecy (Savoy) show a sharp jump in sedimentation at the precise point in the thirteenth century when local monastic estates converted from woodland to arable exploitation. In the Mediterranean basin, cumulative effects of small scale clearances, drainage,

and irrigation works greatly changed the hydrology. Coastal deposition and marsh formation in Sicily and southern peninsular Italy are evident from the twelfth century. Embayment along the Gulf of Lions, stable since Roman times, filled in or became lagoons during the Middle Ages. In northern alluvial zones and estuaries the unintended changes induced by these human activities were abrupt and dramatic. Rates of alluviation in the upper Thames valley during the eleventh through thirteenth centuries surpassed all other postglacial periods. Soil erosion in Germany averaged less than five millimeters per annum for several millennia, but after woodland cover was reduced to a mere 10 percent of surface area, periods of extreme precipitation during 1313–19 caused the rate to peak at about five times the norm and again, in 1342, at fifteen times the norm. ((Hoffmann 2008: 26-27)

The landscape of medieval Europe was changing at a rapid rate from the late 11th century to the early 14th. Europe was moving from small-scale local anthropogenic adaptations to large-scale continental change. The Crusades was a dramatic undertaking of this large-scale organization that largely united and reshaped the continent economically and ecologically. Local geographic and biological differences dramatically diminished as cereals, especially wheat, became more plentiful, while the diversity of edible plants diminished as more land was deforested and cleared. The local wild animal life also was dramatically being diminished in numbers while certain livestock, especially cattle, were increasingly present throughout the continent. This transformation would continue, but it all grew out of the same social organizational and economic foundation that supported centralization of power through different hierarchical systems, an agricultural system that would produce surpluses that would allow for the relatively extensive development of non-agricultural specialists, a strong rule of law, record keeping and accounting of wealth, all of which held up the lifeblood of it all, trade.

1.10 Herding and Farming Dynamics in the Quest for the Vital Resource of Fertile Lands

The demand for land that was productive for commodities of high market demand quickly leads to increased competition for available territory for the right of ownership and how the land will be used. Angourakis *et al.* illustrate this phenomenon in what they name the Musical Chairs model, below:

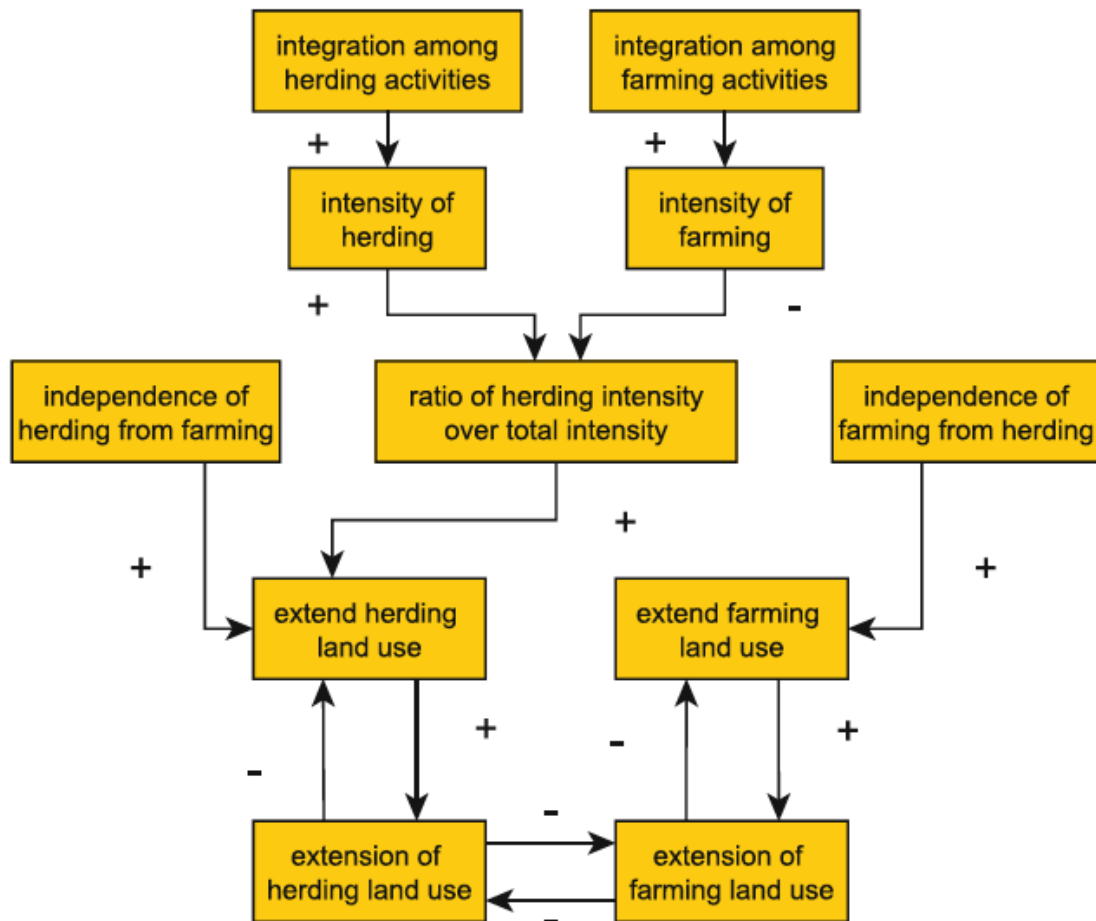


Fig. 1.2. The give-and-take relationships of herding and farming with regard to land use patterns, according to the Musical Chairs model (Angourakis et al.,2014:410).

As illustrated above, Angourakis *et al.* observed that lands would typically be dominated by either herding or cultivated agriculture and rarely have the two sustainably co-existed. They explained changes in this competing use of the territory through four main conditions that impact the changes in land use by the different players, herders and agriculturalists. These characteristics are as follows:

- (a) Extension. How many chairs (desired land areas) remain untaken by players of the same kind, or what opportunities there are to further extend a given type of land use. The more extended a class of land use is,

the less likely it will be extended. This will remain the only relevant factor until there is no vacant chair available.

(b) Intensity. How strong are the players disputing a chair, or how many people and resources are involved in the competing variants of land use. The more intense a variant is, the more likely it will stay.

(c) Integration. How many associates do players have within their own class, or how many people and resources involved in land use variants are also dependent on other variants of the same type. The more integrated a class of land use variants is, the more likely it will be extended.

(d) Independence. How well players value those of the other class, or how many people and resources involved in land use variants are also involved in or dependent on variants of the other type. The more independent a land use variant is, the more likely it will stay and compete (Angourakis et al.,2014:410-411)

Angourakis *et al.* go on to illustrate the different basic characteristics of farming and herding and how that affects the “game” of “Musical Chairs”. They state that farmers are always “sitting” on their chairs in that herders are not able to use their land while they are settled on it. However, herders move from one area of grazing land to another, largely based upon seasons. This gives the opportunity for farmers to come in while the herders leave to another area. Once all the desired lands are taken, then each player still standing must try to displace a player of another class (herders displacing farmers, or farmers displacing herders) (Angourakis et al.,2014:411) . Angourakis *et al.* note that typically a region will have one class of land users or the other will dominate, a mixed use region is the most atypical. They also explain that “tipping points” are key to consider, which are,

...crossing of parameters thresholds [that] can lead to drastic and rapid changes in the equilibrium...The rapid and radical breaks of settlement pattern which are often visible through the archaeological record...could

be showing how an underlying mechanism of competition for land use responds to changes at other levels [e.g. the introduction of horses, the opening and closing of trade routes, the growth and competition of polities]. (Angourakis et al.,2014:422-423)

As herders have a safe haven of grasslands they can go back to while also pose a raiding threat to agriculturalists, it would seem that this region would be in the process of becoming more dominated by herders. Angourakis *et al.* also observed that the degree of connectedness of a territory to other lands where people are able to assess resources for agriculture and/or herding may increase the amount of territory used for both farming and cultivation. Conversely, a closed territory is especially likely to be dominated by farming or herding over the other (Angourakis et al., 2014:422-423).

It should be noted that the agriculturalists are intrinsically tied to the land, which renders this activity as especially susceptible to be taken over by a military power and part of a centralised system of authority. Bureaucratic organisations require agriculturists for food surpluses to feed soldiers and other non-agrarian labour specialists as well as to generate wealth through trade. Herders are not as vulnerable to be under such centralised governments as they have substantial mobility, and with that greater flexibility and adaptability to find alternative grazing lands and food resources in different regions.

V. Centralised Socio-Economic Systems & Institutions, the Development of Normalised Human Labour, a Homogenised Landscape, & Heightened Risk for a Zoonotic Epidemic

1.11 The Development of Standardised Socio-economic Systems & Institutions Through the Centralisation of Property, Production, Economy, Society, & Thought

Landscapes are naturally diverse, supporting different ecosystems depending upon altitude, the degree of moisture in the soil, temperature, seasonal changes, etc. However, the homogenisation of the landscape developed through the large-scale trade-based economy, where people depend upon cash for their needs

rather than the natural environment around them. These man-made ecological changes are a symptom of civilization, which depends the development of wealth to support its military and defence apparatus, as well as non-agricultural labourers. Since human activity is key for understanding risk of a zoonotic epidemic, as Plague, we must understand the systems and institutions that foster these activities that increase the exposure of human populations to zoonotic disease. Since globalisation has its roots in medieval Europe, it is during this period that the foundation of the socio-economic systems and institutions were formed.

The Church that first united Europe, not only religiously but through Canon Law, trade, educationally through Latin, grammar, and numerology, against the threat of heresy, and war. Additionally, the Church was a hierarchical organisation that had a strong presence in most localities throughout Europe, including a strong influence on the secular administration of a nation. The kings needed the Church to support their role, while also needing the Church's expertise in administration, law, and of the educational skills needed to run such an administration and a growing, cash and trade-based economy. This was needed to develop wealth for a strong military, a prerequisite for a king to stay in power.

The Crusades were a manifestation of the Church's new found power to unite Europe and further strengthen its power. However, for this to take place, wealth had to be garnered and that was mostly done through cash-crop agriculture and large-scale animal husbandry. Markets for certain commodities increased the demand for certain goods, leading to an increasingly expanding cultivated landscape that was looking more similar from one nation to the next. Thus, local ecological knowledge had a decreasing impact on the ecologies that people lived within as the centralising forces of the Church and secular nations brought about the standardisation of manor systems and the labour that developed them into wealth-building enterprises through the systematic exploitation for agricultural commodities in high market demand.

1.12 Cultural Transformation Through Monetization: The Social, Economic, & Intellectual Unification of the Vast Trading Economy

The Monetization of trade leads to a profit/loss focus mindset in decision making that relies upon knowledge of law, contracts, factors of production, and accounting. The need for this knowledge increases the demand for skills of literacy, numeracy, and the translation of qualitative values into quantitative. The concept of translating qualitative values into quantitative is something that is demanded by a market economy. Putting a monetary value on a good or service has been part of the translation process demanded of a cash economy, which also fosters other measurements, as size and weight of a good, to be measured in a quantitative form that would be easily translatable to a monetary value. Thus, we can measure the weight of a bag of wheat and pay according to its quantity. However, since quality is much more difficult to measure due to the various factors involved, it is not measured. It is in this way that the cash economy favours quantitative over the much more difficult to linearly measure, qualitative value of a good or service. Kaye explains the cultural transformative impact this has on a society,

The accelerated use of money had ever-expanding social, economic, and intellectual consequences. As the process of monetization gathered speed, habits of thought and perception initially restricted to those actively engaged in commerce came to be adopted by members of all segments of society. Among the most characteristic of these new habits were: the focus on monetary profit and loss in a wide range of decision making; the recognition of the importance of detailed written records for this calculation; the resulting broad development of literacy and numeracy; and the translation of qualitative values into quantitative, often monetary, terms as a way to simplify the process of calculation. The gradual spread of these habits had important historical consequences, especially when they were adopted by administrators of the incipient royal and papal bureaucracies (Kaye, 1998:285).

The cultural divide between a society intimately tied to its cultural geography and one based in a cash, trading economy effects their respective cultural importance put upon qualitative and quantitative factors. These factors are tied to how the people make a living and thus alter their view of the world. This difference is exemplified by Whorf, an early twentieth century fire insurance

claims investigator turned linguist who interestingly observed the greater vulnerability of people that spoke English and other European languages to fall victim to a fire compared to indigenous languages, such as Hopi in the U.S. southwest. He gave an example of the storage of “empty” gasoline drums that in the European languages means ‘null and void’ and suggests a lack of a hazard (Whorf *et al*, 2012:135). However, the Hopi would not have described the drums in a “category such as a number” but rather would have described the qualitative characteristics in depth (Whorf *et al*, 2012:138). This is not to say that the Hopi did not use cash and trade, but their intellectual and linguistic comprehension through the Hopi language was predisposed to express the qualitative characteristics of potential hazards.

This translation process of qualitative values to quantitative is an important focal point as this is at the core of the reconceptualization process of nature, part of what John Murdock called a “natural philosophy without nature,” (Kaye, 1998:285) where numerology/mathematics replaces observation of nature as the definitive source. Ecologies, and the ecological services they produce, are part of a complex and interdependent processes, whether we are speaking of systems within organisms within an ecology, the ecology itself, or the interlinking of one ecology to the next, which depend upon each other. Nothing develops in isolation. However, accessing change in isolation is exactly the basis for the “natural philosophy without nature.” Values are extracted based on monetary value, weight, volume, etc. and then a particular number represents the “quantitative value” of some life, entity, or phenomenon in nature. This numeric value, unlike anything in nature, does not change and has a permanent value.

1.13 The Rise of the Trading Economy and Quantitative, Linear Thought

Intellectual innovations within fourteenth-century natural philosophy occupy an important place in the history of scientific thought. Over the course of the century, philosophers subjected elements of the Aristotelian model of the natural world to critical analysis, advancing claims of logic, mathematical consistency, and empirical evidence against Aristotelian authority. The selective critique of

Aristotle was informed by a wealth of new questions and innovative speculations. Beneath these speculations lay a profound reconceptualization of nature (Kaye, 1998:18).

The tie to the Greek and Roman worlds had much esteem during this period as the trading economy lived through Levant and Egypt as well as the Church, whose Roman-influenced organization, institutions, law, language, and trading economy saturated the European theocracy. Greek thought, particularly that of Aristotle, was especially influential at the time. The early European universities sought to “reconceptualize nature” by not teaching to observe nature to learn the foundation of esteemed knowledge, but through logic even to the point of explaining the Trinity using a mathematical formula (Haskins, 1927:30-31). Kaye explains this medieval world view using Aristotelian logic instead of direct observation,

Within the medieval university the term *scientia demonstrative* applied not to demonstrations by experience but to a system of syllogisms and propositions satisfying the Aristotelian requirements of logical demonstration. With few exceptions, philosophers believed that the certainty required of science was to be found through the application and the *test of technical logic rather than through direct observation of contingent object world*. (Kaye, 1998:164)

The focus on logic instead of direct observation of nature, resulted in “A complex and dynamic vision of the natural world emerged within fourteenth-century natural philosophy and, with it, a cluster of logico-mathematical languages capable of describing and bringing order to this vision.” Kaye (1998:164) also notes the Oxford Calculators were especially diligent in seeking to “cleanse their language and logic of the contamination from the contingent world of both society and nature.” (Kaye, 1998:165). This drive to separate truth from nature is also observed in that:

In order to attain its required necessity and universality, the proper objects of demonstrative science must be propositions rather than natural phenomena. In positional-difference logic, propositions found verifiability in the internal fit and agreement of their parts rather than in

their agreement to sense observation. Truth or falsity was judged in isolation from the world of contingent objects (Kaye, 1998:164-165).

This isolation from the world of contingent objects has important intellectual consequences to consider. Though isolation brings about greater identification and control of the variables, which arguably lessens the margin of error, it also lowers the level of cognition. Using the popular Bloom's Taxonomy of Cognitive Levels, this Educational Psychology's guide to the depth of cognition that is related to different types of knowledge, shows that high cognitive levels (Synthesis and Evaluation) require "The ability to put parts together to form a new whole."

Bloom *et al.* (1956:20-24) explains each of these cognitive levels below, from the least advanced learning, *Knowledge*, to the most comprehensive, *Evaluation*:

Knowledge

"involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting."

Comprehension

"refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications."

Application

The ability to use learned material in new and concrete situations. "refers to the 'use of abstractions in particular and concrete situations.'"

Analysis

"represents the 'breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between ideas expressed are made explicit.'"

Synthesis

“involves the ‘putting together of elements and parts so as to form a whole.’”

Evaluation

“engenders ‘judgements about the value of material and methods for given purposes’ (Bloom, 1956:201-207).

The focus on isolation and specialisation thus may be training people to synthesis and evaluate to a lesser degree than would be seen in a substance economy, where the focus would be on these higher cognitive areas. Since subsistence economies did not have much in the way of wealth surpluses, making a continually accurate synthesis and evaluations would have been more crucial to their daily survival. Therefore, taking a more holistic view quickly, leading to higher cognitive thinking, would have been very functional in the more traditional socio-economic system and less of a daily necessity in the trade-based system. Kaye makes an additional observation that the origin of a linear thought process may be tied to the monetization of society.

...writers on money from Aristotle through the scholastic theorists to the twentieth century have realized, **money in fact functions as a *line***, a connecting *medium* (to use the word attached to it by Aristotle and the scholastics), a measuring scale composed of a divisible and expandable *continuum* of value. All goods, all commodities, all services (as Jean Buridan noted, even highly subjective services that at first glance seem immeasurable) have their values expressed in terms of their price, i.e., their position on this common, numbered, measuring line or continuum. (Kaye, 1998:171)

The linear process may be vulnerable in not identifying and accounting for many variables. For instance, in a natural ecological system it is not feasible to have a linear process for the interactions that take place are not constant, and may be in interaction loops, it depends on the species involved, as well as other factors such as climate, other species and variables present. Thus, types of interaction are variable and though can be predicted, but it is more difficult due to the constant state of flux that generally goes through similar yearly patterns.

More complex forms of mathematical calculations could theoretically deal with more complex contextual situations by incorporating approximations of the

impact of different variables, especially in a more controlled circumstance. Kaye illustrates the tie to the use of such formulas being used by students and masters living in commercial centres, as procures and financial officers in universities, natural philosophers of the fourteenth century to manipulate...the instrument of money:

...the technological form of money as the following: an extendable, divisible, graded, and numbered continuum used as a common measuring scale, capable of expressing constantly shifting and diverse values in common numerical terms, and thus facilitating relation between seemingly incommensurable goods and services in exchange. (Kaye, 1998:171-172)

The vulnerability of error here is that even if all the mathematical formulas truly and accurately reflect natural phenomenon is that the original numeric value given to some form, phenomena, etc. is a simplification, typically made based upon measurement values of one or two variables. This figure is then put through various calculations, which means the margin of error is magnified (to what degree depends upon the calculation). Thus, the greater the complexity of the problem, the greater the margin of error it will have. The less controlled the environment is the more variables that will not identified and controlled for, the greater the margin of error. Though mathematic formulas can never account for every variable even in the most controlled settings, the most controlled settings can lead to very small margins of error, leading to successful manufacturing settings, for instance. However, the more natural setting is in a state of constant change with different factors moving in and out of the setting being studied. Therefore, the identification and control of variables is going to be especially poor, leading to very high margins of error and very significantly less dependable results.

1.14 Intellectual change as the foundation for an expanding trade-based economy

The growth of in the importance in the rapid and extensive exploitation of resources and large-scale trade gave an opportunity for the economic class of

merchants to develop. Merchants often rose from a lowly status to a “great social and political power over the course of the long thirteenth century,” (Kaye,1998:285) which “presented a newly rationalized model of behaviour and perception, leading individuals far removed from commerce to imitate their modes of thought and activity.” Kaye (1998:285) further illustrates this intellectual change based upon the greater dependency on the market economy in exemplifying the change of how a natural environment was assessed in value,

The commercial habit of measuring and calculating in monetary terms was extended to all manner of things. Where previously, for example, forests had been primarily valued by lords for the status and pleasure they afforded, they came in the thirteenth century to be seen as income opportunities, as resources to be rationally exploited toward the end of profit (Kaye,1998:285).

This is an important point as ecological services, which is a complex, interdependent process from the micro-level (as microbial systems in and on our bodies, which play a vast rolls in our immune systems), insects (which may be herbivores, carnivores, omnivores, as well as very niche specific or generalist), to plant-life (some which may produce food for human consumption, others may produce food for other insect and animal life while its decomposition fertilizes the soil and gives the plant-life nutrients), and wild and domesticated animal life. However, the dependence upon a cash-economy led to focusing on agricultural production, rather than how to sustainably extract resources from the ecosystem. This societal change of focus has been called a “revolution in attitudes towards money” (Kaye,1998:285). This was not without resistance though, as Kaye states, “Despite the fervent warnings of moralists, money was becoming the measure of all things” (Kaye,1998:285). Money, wealth generation and moral issues were key issues for some of the religious orders of growing popularity of the time, as Swanson explains:

This commercialization was not universally welcomed, and commercialization alone would have been insufficient background or stimulus for the twelfth century’s cultural and intellectual changes. The problems raised by the new economy did not have to be confronted; they could be shunned. Attacks on usurers in many ways ignored economic

potentialities and realities; many sought to evade rather than resolve the emerging tensions by a radical rejection of 'the world.' This is a particular characteristic of religious movements in the period, ranging from the hermits and early Cistercians of the late eleventh century, through the poverty movement of people like Waldes in the twelfth, to the apostolic poverty of St. Francis and his followers in the early thirteenth (Swanson, 1999:8).

Though substantial resistance occurred, especially in the religious orders, resistance proved futile, even within the orders. The Cistercians, in particular, were transformed into an economic powerhouse of great wealth. The order's discipline, hard work, and commitment to humble material existence were the ideal characteristics to generate a huge surplus of wealth. Economic wealth brought the order broad attention, as it was thought that a Divine connection was the origin of any organization or society that thrived.

VI. Assessing Socio-Economic System & Institutional Ties to Human Zoonotic Epidemics Through Modern Outbreaks

1.15 Language, Enculturation, and Vulnerability

The public political support of the colonizing European nations was largely based upon the premise that they were developing the education and economy of those they were colonising, not least of which was through learning a European language and following the colonial system of education. However, this educational shift that took place in many regions from an education based upon observing the local ecosystems to that based upon reading/writing of a foreign language and mathematics, essential for a trade-based economy, may have left people more vulnerable for a zoonotic epidemic. It is evident that most of the colonies in Africa and Latin America, which previously had low settlement rates, which changed with European colonisation with large-scale, cash-crop agriculture and mining. These changes led to extremely high death rates to support the European trading economy (Acemoglu, Johnson and Robinson, 2000).

Different vulnerabilities seemingly were not often realized, but European languages in the colonized lands may have lead to increased vulnerability. Benjamin Whorf (1956: 134) explains:

Human beings do not live in the objective world alone, nor alone in the world of social activity as ordinarily understood, but are very much at the mercy of the particular language which has become the medium of expression of their society. It is quite an illusion to imagine that one adjusts to reality essentially without the use of language and that language is merely an incidental means of solving specific problems of communication or reflection. The fact of the matter is that the “real world” is to a large extent unconsciously built up on the language habits of the group...We see and hear and otherwise experience very largely as we do because the language habits of our community predispose certain choices of interpretation

Whorf investigated numerous incidents to illustrate the linguistic problem, the lack on descriptiveness of potential hazards (Whorf, 1956: 135-137). Though the English description could have been elaborated on to increase awareness, his argument is that many non-standard European languages are inherently more descriptive of physical attributes, thereby significantly diminishing the potential hazard. Whorf illustrates one of these vulnerabilities through examples of non-descriptive words, “lumps, chunks, blocks, pieces, etc.” as examples of “our language patterns (that) often require us to name a physical thing by a binomial that splits the reference into a formless item plus a form” (Whorf 1956: 141).

Whorf uses the example of the Hopi (a relatively isolated Native American people (Dockstader, 1979: 524) language, whose nouns inherently have form and the verbs “have validity-forms (“assertions”), aspects, and clause-linkage forms (modes), that yield even greater precision of speech. The validity-forms denote that the speaker (not the subject) reports the situation (answering to our past and present) or that he expects it (answering to our future) or that he makes a nomic statement (answering to our nomic present). The aspects denote different degrees of duration and different kinds of tendency ‘during duration’(Whorf, 1956: 145-146). Whorf (1956) later continues to describe a Hopi part of speech that expresses duration, intensity, tendency, duration, and sequence: “The function of the ‘tensors’ (Hopi part of speech) is to express

intensities, 'strengths', and how they continue or vary, their rate of change; so that the broad concept of intensity, when considered as necessarily always varying and/or continuing, includes also tendency and duration. Tensors convey distinctions of degree, rate, constancy, repetition, increase and decrease of intensity, immediate sequence, interruption or sequence after an interval, etc., also QUALITIES of strengths, such as we should express metaphorically as smooth, even, hard, rough" (Whorf, 1956: 146).

Whorf argues that the inherent descriptions of a physical environment in Hopi and other indigenous languages diminish risk by design. However, these languages also have awkward ways of expressing plural nouns, counting, measurement, and expressing mathematical assessments, which is a characteristic of what Whorf calls Standard Average European (SAE) languages. I argue that languages with attributes of counting and measurement are adapted to the trading economies they are associated with. Whereas indigenous languages are associated with knowing the ecosystems that they depend upon and need to sustain. Indigenous languages are not well suited for a trade-based economy, and European trade-based languages are not well adapted for observation of the physical environment that we live within.

The purpose of languages is to give the most efficient and descriptive tools to assist in the cultural economy that one lives within. Trading economies are based upon the efficient transfer of goods and services, which is done through a cash economy. Thus, putting a numeric value on weight, time, how much a good or service is worth, increases the efficiency of the economy (see chapter on the trading economy in Ireland for the medieval development of the cash-economy and the change of language, as well as academic and common European thought process). However, numeric values are also generalisations that leave out many details (Chen, 2015). For instance, counting the number of people in a city leaves out much information. The rate of consumption, skills, habits, wants/needs, physical sizes/dimensions, resources depended upon in La Paz, Bolivia certainly has little to do with Los Angeles, California. Thus, two cities with about the same population may have very different characteristics. However, numeric estimating is part of the norm with our European trading languages. This is not

the case with indigenous languages, which give approximations by giving as much description as possible of what is being described.

1.16 Education and language in a trading v. subsistence economy

Now it must here be understood that ink is the great missive weapon, in all battles of the learned, which, conveyed through a sort of engine, called a quill, infinite numbers of these are darted at the enemy, by the valiant on each side, with equal skill and violence, as if it were an engagement of porcupines. (Swift 2010: 221).

The importance of learning the written word of a coloniser or of the dominant powers in our globalised world gives more power and influence to local people. Thus, the incentive for learning such languages is high. However, it is the natural environment is the basis of survival for all that is living on the earth. Knowing and adapting to the environment one lives in, has been essential for survival for humanity as well as the rest of the animal world. All that lives in an ecosystem needs to know what they require for survival, what their niche is, and which behaviours/interactions result in a greater chance of survival. Therefore, learning about one's natural surroundings, what nourishment it yields at various times of the year, what can be manipulated to increase the food supply, what are signs of vulnerability to the system and what could be done to minimize these vulnerabilities, is essential. This is a complex process of reading the ecological system one lives in (i.e. climate, insect/animal behaviour, plant health, soil/humus fertility, etc.), what organisms in the environment are in oversupply (and thus their consumption will not have an adverse effect on the environment), noting the affect they are having on the environment and adjusting their interactions with the environment to increase environmental diversity (thereby decreasing its vulnerability), as well as many other interrelated/interdependent phenomenon. Mgbeolji (2006: 62) explains the interconnectedness of what we are intrinsically and intricately a part of:

Human impact plays a critical role in the multiplication and sustenance of plant species. Plant diversity correlates with cultural diversity. For example of the nine countries that account for 60 percent of human languages, six also have exceptionally high numbers of unique plant species. Remarkably, of the 6,000 living languages, 1,000 are spoken on a

single island-New Guinea... Ten languages die out every year, and as cultural globalization sweeps across the earth, it is not a coincidence that the centres of linguistic and biological diversity suffer the highest rate of language extinction.

Biodiversity does not have to decrease with human presence, as quite the opposite has been true for much of the human experience. Monoculture agriculture (as Mgbeoji notes) is an obvious exception to this, but small scale agriculture was successful for many millennia as it increased biodiversity, which limited vulnerability to insects and disease as different plants have different susceptibilities. Mgbeoji (2006: 62) elucidates, "...the domestication of plants leads to an increased variety. This is due to the phenomenon of polyploidy; that is, the doubling of chromosome numbers. Since agriculture began 10,000 years ago, selective breeding has resulted in stronger, healthier, and higher-yielding plants, thus increasing the diversity of plant species. The greater the cultural diversity of the local farmers, the more likely they are to breed plants for various purposes (e.g. religious or social festivals), thus multiplying the diversity of plants. Put simply, agro-biodiversity is not a strictly natural phenomenon but derives from human activities. Indeed, farmers make selections to enrich biodiversity all the time. In this wider context, cultural diversity and natural diversity are closely linked concepts"

Humanity's interconnection to other life in the natural environment is basic to many indigenous knowledge systems. Norwegian Archaeologist, Gjessing (1967:125-139) explains how connection to the environment seems to be innate to organisms,

Since territorialism seems to be a universal phenomenon among animals, it must have characterized man's mammalian ancestors ... Man's 'instinctive' (pre-cultural) equipment, then, would include elements leading to group cohesion and territorial restriction'. It is well known to biologists that throughout the whole organic realm, a decidedly marked adherence to the group territory, to a local environment, is met with, and that among many animals firmly structured societies are met with. At least among many birds and mammals this local adherence is so strong that they do not permit individuals of the same species, but belonging to

other local groups, to cross the border. The adherence to a local environment can be followed even to one-celled organisms, which caused an anatomist friend of mine to remark, seemingly paradoxically, 'you know, the adherence to the environment is more primary than even the sexual drive'. And in more complex organisms the attachment of the cells to their environment builds the structure of the organism, and comes thereby to be a basic, organizing principle in organic life.

Gjessing (1967) here uses territorialism to mean the area that an organism lives in, their geographic niche. Organisms do live in a habitat that they have grown to know and realize that they can survive, taking many factors in consideration including food availability, climate conditions, and access to potential mates. Gjessing (1967) here illustrates the same instincts that leads human communities to group cohesion with territorial restriction are also known to be present in many mammals and birds. However, this concept of being an interconnected, interdependent part of the natural environment contrasts sharply with the belief that humanity, not nature, is the ultimate source of knowledge, as Mgbeoji (2006: 58). illustrates, "...contemporary scholarship confirms that Western science, like other narratives of science, is in fact controlled by the social world of scientists and not by the natural world"

This may be the most profound difference between traditional knowledge systems and Western knowledge systems. This great intellectual split may indeed be at the core of our present day conflict resulting in cultural extinctions and a more vulnerable, less diverse world. Gjessing (1967: 131). quotes Young in noting a phenomenon of warfare, "The distribution of warfare.... suggests that the level at which such organized conflict is carried on rises as one moves from the food-gatherers to the modern agriculturists"

This conflict between traditional societies and Western/Westernized societies has been escalating, if one accepts Gjessing's (1967) assessment, from the onset of "modern agriculturists." The onset of modern agriculturism has been continually developing to what it is now today, a hugely mechanized, monoculture of mega-farms that is the farthest in history we have been from hunter and gatherer sustenance. Though as agricultural revolutions passed and

populations re-doubled themselves, the threats to traditional peoples intensified as more territory was taken up, by force or legal agreements that were out of their realm of knowledge. These led to ever more frequent cultural genocides. "War, regardless the definition, implies group conflict, and must...be clearly distinguished from inter-personal conflicts; being group conflict, it is a structural phenomenon... However, international wars involve state territories; and the habitat of a people, of course, to a high degree, has an ecological dimension. Conflict and inefficiency in human organization often arise because political entities - local, national and international - so frequently are set up without regard to the extent of ecological areas" (Gjessing 1967: 131).

Today, though there are hot wars continuing between Western/Westernized societies and more traditional societies, this may not be the main threat to traditional cultures. The present battle between nations of Western/Westernized knowledge systems and more traditional/indigenous knowledge systems is regarding the rights to keep their ecological roots. Ostergard, Tubin, and Altman (2001:643) argues,

...globalization has pushed governments, biotechnology firms and universities into strategic alliances that have unfairly included another partner in the creation of these new products: the developing world...While most of the technological developments in the biotechnology industry are centered within the developed world, most of the biological resources that are used in this research are located in the developing world...This process, of sending scientists off for a new discovery to often remote, diverse ecosystems is called biodiversity prospecting, or biopiracy by its critics.

Ostergard, Tubin, and Altman (2001:643) explained the changing international scene through noting Strange's work, *The Retreat of the State: The Diffusion of Power in the World Economy* (1996), "...international relations theorists must move beyond the unitary state explanation for international relations...In part, structural changes in the world economy have led to a shift in international diplomacy: governments are forced to bargain, not only among themselves, but also with corporations, while corporations are forced to negotiate among

themselves as well as with governments...Strange argued that what has changed the nature of competition have been technological advances, capital mobility and improved transborder communications and transportation. Competitive pressures are forcing governments to compete more actively for world market shares while trying to accommodate the needs of each other". Shiva (1997: 8) states, "Indigenous knowledge systems are by and large ecological, while the dominant model of scientific knowledge, characterized by reductionism and fragmentation, is not equipped to take the complexity of interrelationships in nature fully into account."

1.17 Pre-Colonial Education

(Children in pre-colonial Africa) learned by living and doing. In the homes and on the farms they were taught the skills of the society and the behaviour expected of its members. They learned the kind of grasses which were suitable for which purposes, the work which had to be done on the crops, or the care which had to be given to animals, by joining with their elders in this work. They learned the tribal history, and the tribe's relationship with other tribes and with the spirits, by listening to the stories of their elders. Through these means, and by the custom of sharing to which young people were taught to conform, the values of the society were transmitted. Education was thus 'informal'; every adult was a teacher to a greater or lesser degree...(This informal system that garnered guidance from the full spectrum of societal experiences) may have made the education more directly relevant to the society in which the child was growing up. (Fafunwa 1982: 9-10)

Fafunwa (1982) illustrates the communal education that children would typically receive in pre-colonial Africa that highlights the direct preparation for young people to be strong contributors to their society. By gaining instruction and insights from the different adult members of the society, the education promoted a greater base of reference, thereby instilling holistic thought processes. Instilling a holistic way of thinking, fosters sustainable decision-making that does not put too much emphasis on particular factors/variables while putting little or no importance on others. This broad practical and intellectual foundation helps promote sensitive powers of observation as well as

adaptability and flexibility to address various circumstances that may develop (Fafunwa. 1982:9-10).

The contrast between education of traditional indigenous peoples versus a western one, is illustrated below by Alaskan scholars, Barnhardt and Kawagley (2005: 11). Here they explain the difference between the Western perspective and the traditional indigenous ones:

While western science and education tend to emphasize compartmentalized knowledge which is often de-contextualized and taught in the detached setting of a classroom or laboratory, indigenous people have traditionally acquired their knowledge through direct experience in the natural world. For them, the particulars come to be understood in relation to the whole, and the laws are continually tested in the context of everyday survival. Western thought also differs from indigenous thought in its notion of competency. In western terms, competency is often assessed based on predetermined ideas of what a person should know, which is then measured indirectly through various forms of objective tests. Such an approach does not address whether that person is actually capable of putting that knowledge into practice. In the traditional Native sense, competency has an unequivocal relationship to survival or extinction if you fail as a caribou hunter, your whole family may be in jeopardy. You either have it, or you don't, and it is tested in a real-world context.

Traditional societies living within their cultural geographies in a subsistence economy requires an intimate tie to the ecosystems they depend upon. Therefore, the education that fosters the intellectual foundation of this cultural economy needs to deliver sensitively accurate, holistic observations and practical applications of those observations. This gives the basis for the sustainable use of resources in consuming what is in abundance or over-supply as particular geographic areas and moments in time.

Conversely, the western cultural economy based in trade and the development of wealth surpluses is founded on fostering greater consumption, which increases trade and potential profit. The build-up of wealth depends on many factors including market prices, and the major markets may be a continent away. Thus, the connection of survival to knowing one's locality is diminished, and the

development of wealth through technological development and international awareness of foreign markets is heightened. The intellectual differences and commonalities between traditional indigenous knowledge and western science are illustrated in the diagram below:

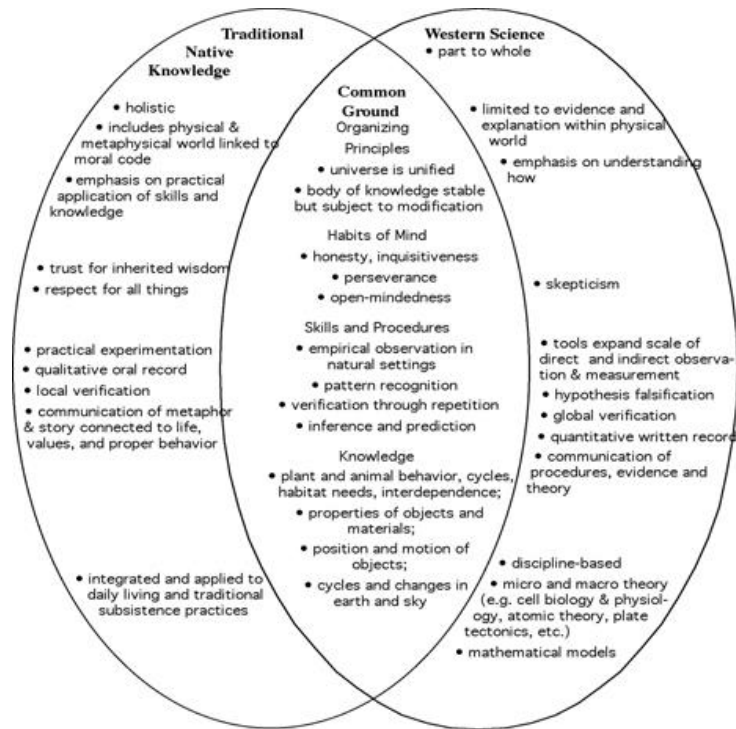


Fig. 1.3. Stephens' Venn (2000) diagram comparing Traditional Native Knowledge to Western Science.

1.18 Colonial Education and Language

Establishing the Importance of the Colonial Language in New Lands

Familiar literacy and cinematic images of heavily armoured conquistadores routing natives in military engagements mask the importance of reading and writing in the conquest of the New World. While military might took control of the land and the natives, “the *right* to rule was established by language and ceremony. (Seed, 1992: 111)

The authority of the word is used to give both religious and secular leaders the right to rule. In the west, this stems from the Roman Empire in the shift from authority based from nature to one based from the rule of law and sacred scriptures. Seed illustrates this right to rule that was formulated during the colonization of the Americans:

Even as the conquest of the New World was often accomplished by military means or by occupation, its authority-that is, the right to rule was established by language and ceremony. For Columbus, it was the ritual landing of the royal banner and twin flags, together with the language of his well-witnessed solemn declarations, that established the right of the crown of Castile to this territory... Columbus's first step was to mark his presence on the land-the customary first element in the Roman tradition of taking possession... The second part of the Roman-derived conception of possession was manifesting intent to remain, which Columbus did, in his son's report, by "appropriate ceremony and words.(Seed, 1992: 184)

European monarchs quickly standardised the legal processes of authorising their right to rule in colonial lands after Columbus' expedition (Seed, 1992: 184). The Pope originally had legal authority, but the monarchs increasingly separated themselves from this subordination. However, Christianity was established as the only faith of righteousness that was deemed a pre-requisite for territorial possession to be respected by Europeans. (Seed, 1992: 185) As Seed notes, lands cannot be barbarians and heathen, rather this gave the excuse to take the land by force from non-Christians. Being Christian did not guarantee that a people's territorial possessions would be respected, especially in the case of the English

that did not defer to the Pope and later established that possession as nine-tenths of the law (Seed, 1992: 183-209). Nevertheless, there are historical accounts to give more consideration to lands that were said to be under Christian rule. For instance, it was common practice for European explorers to put a cross on new territories that signalled their possession.(Seed 1992: 183-209)

Secular leaders gained authority from the hierarchy of the church and through legal institutions. Thus, increasingly through the colonial period, ownership over new territorial possessions was in a legal context that granted authority. Therefore, it was through literacy and the understanding of legal procedures that authority was gained and potentially fought. Accordingly, the colonised people who learnt the language and studied the system of education of their colonizer had many more opportunities than their brethren. As such, the incentives for a western education ran high.

Text, power, and identity through the coloniser's words were essential for the submersion of indigenous connection to their cultural geography that was interwoven with their languages and education. The written word and education were vital for the transformative process of intellectual enculturation of the colonized by the colonisers:

Recognizing the interrelatedness of text, power, and identity is unavoidable when one turns to investigate the relation of colonizer to colonized. Colonial encounters, from their inception, were marked by a clash of unequal powers engaged in struggle: on the one hand, by aboriginal peoples to resist the encroachment from without which sustains it, and, on the other hand, but the colonizers to remake the subject populations into Christians, both politically subservient *and* literate. The colonizing effort was all too often written not as a history of capitalist expansion, but as a massive, entirely laudable, educational enterprise bringing enlightenment and religion to those left behind in the civilization process. Such a view masks the actual history of political and economic domination, sanctioned by church and crown, which resulted in the destruction or radical transformation of indigenous cultures throughout the non-Western world.(Collins and Blot. 2003: 121)

The intellectual transformation that occurs to change from a subsistence economy based in a population's cultural area to being colonized as part of a multi-national trading economy is tremendous. Text limits the realm of discussion to what is put on the page, and education based on text only allows advancement through being able to have a strong grasp on that information, even if that is not in accordance with ecological realities. The written word is a crucial part of the intellectual specialization in that it allows information to be taken from its context and be continually manipulated in an evolving pseudo-reality. The western scientific urge to identify and control variables instigates the desire to remove as many variables as possible. This means that the intellectual removal of the context to be able to narrow the focus on particular aspects of a phenomenon being studied and dissect them into individual variables is fundamental to the thought process. The written language is vital for the advancement of this dissection process, which allows specialisations and sub-specialisations to be developed. This intellectual dissection process is so deeply ingrained in today's globalised world that it is difficult to see an alternative cognitive process to interpret reality. Clanchy explains, "Literacy is unique among technologies in penetrating and structuring the intellect itself, which makes it hard for scholars, whose own skills are shaped by literacy, to reconstruct, the mental changes which it brings about"(Clanchy, 1979: 149)

The development of this compartmentalised system of cognition is crucial for the development of trade-based economic systems. Thus, colonized people that are educated in the western ways of thinking formed the elite class of a new colony, for they are the ones that understood how this socio-economic system functions and how to benefit from it (Collins and Blot, 2003: 121). They were conduits to indigenous knowledge and how that can be profited upon in the global economy. According to Ostergard, Tubin, and Altman (2001: 650) "universities and corporations see indigenous intellectual property as a fountain of potential research for consumer products...The 'shaman' is no longer a 'crazed witch doctor' but someone who possesses knowledge of interest to corporations. Corporations and universities often engaged in a massive effort to find new products through knowledge in the developing world...Often researchers

‘discover’ existing products or ‘new’ uses of them that have been in indigenous communities for centuries. They are then able to obtain patents for these products, which gives them exclusive rights over the products or procedure. As companies patent their products in multiple countries, the potential exists one day for indigenous groups to be prohibited from using their own cultural heritage and knowledge.”

The concept of ‘Rights’ of ownership predetermines a colonial, trade-based economy, and a colonial way of thinking. This colonial ownership expansion is true for land, resources, and goods, as well as knowledge that is deemed economically valuable. Thus, learning the economic and economic systems, as well as the colonial language is important for a people’s survival and to somehow defend their own rights. Accordingly, the value of indigenous knowledge of the colonized is greatly diminished by the indigenous population, since it is vulnerable to such legalistic intellectual raids for economic wealth. Additionally, indigenous knowledge, which is rooted in the ecologies a people have depended upon for generations, has suffered as colonisation has also meant an increase of forced migrations and with the unsustainable use of resources brought on by colonial forces (Cajete, 2000: 85-106). Additionally, witchcraft and occult practices are largely believed to be on the increase *after* colonisation (Moore and Sanders, 2003: 8-9) as Ward (1956:47) explains the Ashanti example,

“...it appears that in Ashanti [of present day southern Ghana] ten years ago increased European contact, an extension of social scale, rapid economic advance, political change, and the spread of Christianity and school education had been accompanied not simply by the persistence of witchcraft beliefs but by their very considerable increase, and by the emergence of new cults designed to deal with them.”

Social institutions are constructed to solve societal problems, but the belief of indigenous communities to fall back on traditional knowledge has been weakened and has resulted in a shortage of needed resources, as food, as well as the development of many unprecedented problems. Marwick (1958:112) explains, “Wherever modern changes have brought about situations for which there are no indigenous precedents, and problems of tribal rules of thumb can offer no solution, these tensions arise and are often expressed in terms of

witchcraft.” Thus, the ‘globalisation’ of witchcraft and occult practices has developed as Moore and Sanders (2001: 15) illustrate,

A large body of evidence from Africa suggests that witchcraft and other occult practices are intimately bound up with peoples ideas about production, exchange and consumption. The flows of information, goods and people characteristic of globalization are seen as incorporating some and excluding others: the processes of differentiation and privation that result are viewed as predatory and illicit forms of exchange. The terms of exchange equate people and their body parts with commodities, their life-force with ill-gotten wealth and their fertility with immoral consumption.

This process of globalisation has affected people differently, but the impact of cash dependency, large-scale trade, increased consumption, and unsustainable resource use is felt around the world. Consequently, ecological deterioration follows as natural resources extraction and cash-crop agriculture escalate. Since the goal of having colonies is to gain these raw materials at a cheaper price, the transformation of the colonized people to depend upon the trade-based economy for their own survival was fundamental. Therefore, those under colonial and post-colonial rule live in cash economies, and as such, most depend upon an over-exploitive economy for their livelihood.

1.19 Colonial to Globalised Education of Masses

The World Bank’s involvement in education policy and reform has grown substantially since the 1960s. For an organization that originally had no mandate to work on education, the Bank has become perhaps the most powerful and hegemonic of the international organizations operating in the education for development field. The Bank is the largest single international funder of education for development in low-income countries, and its technical and knowledge-based resources tower over those of other international institutions. (Mundy and Verger, 2015: 9)

The 1960s were known as the time of independence for African nations, in the case of Tanzania the social services development policies centred on the

eradication what was referred to as the “three major enemies of human development” specifically ignorance, disease and poverty but it is also the time the World Bank became involved in investing in the education of developing countries. The World Bank seemed to come in when colonial investment tapered off. Brock-Utne (2000: 24), using Tanzania as a case study, describes the World Bank’s relationship with the government and its educational investments,

...the distrust of the World Bank and also by Norwegian officials has led to the undermining of the role of the Ministry of Education and a creation of an NGO that never would have been there had it not been for donor money. The local politicians and educational experts have been bypassed, and their warning that this fund would lead to greater inequalities within the education system in Tanzania has been ignored. As several studies show, the NETF has increased the regional and religious inequalities in access to secondary education in Tanzania. Almost 40% of the NETF funds go to schools run by Christian missionaries. Not a single Muslim school has received any funds. Three of the most wealthy regions of Tanzania – Kilimanjaro, Ruvuma, and Arusha –received more than 50% of the funds, while Kigoma region, which is very poor and has few secondary schools, has received no funds.

The educational funds seem to be going to the regions where European agricultural cash-crops were central to their trading economies. These higher altitude regions are more ideal for cultivating these commodities. The funds also seem to play a role in what is being taught. Colonial language instruction has been a world-wide phenomenon well after colonised lands gained independence. During the period 1970 to 1986, Sub-Saharan Africa had the disproportionate percentage of total instruction time allocated to the Official Language (which is typically the colonial language, as English or French) being almost double that of the local and national language(s), 24.2% to 13.5%, respectively. This is the opposite of the European and Western experience where the national, local is dominant (27.7% National, local language(s) to 3.5% for Official language(s) in Eastern Europe, and 30.3% to 1.9%, respectively, in Western Europe, North America, Australia, and New Zealand) (Benavot *et al.*, 1991: 93). Language study and mathematics were the most dominant areas of instructional time (from 1970-1986), the two typically accounting for over half of the instructional time.

Latin America had a respectively low 42.5% of instructional time in these two fields (due to only 24.4% of instructional time on language study, but it had the highest percentage in Natural Science and Social Sciences) (Benavot *et al.* 1991: 93). Benavot *et al.* (1991: 92) explains their hypothesis for the comparatively less emphasis on language in Latin America:

Latin American countries allocate significantly less instructional time to language education (in total) than countries in other world regions. One explanation is that because Latin America experienced a long colonial period during which indigenous populations were decimated by disease and warfare, Spanish became the dominant language and the need to teach several languages was minimized. Also, many newly independent Third World nations, especially in Sub-Saharan Africa and the Caribbean, have kept the language of their former colonizers as an official language of instruction in primary schools.

Latin America, the Caribbean, and Africa may have had some differences in their experiences of colonisation, as well as independence. However, globalisation through the saturation of trade-based languages and education has had the same net result of establishing a global educational curriculum through a handful of languages is the present reality. Many have noted that worldwide testing and university rankings are tools that penalise local knowledge and expertise as it is solely global material that is compared and ranked. Though it may not come as a surprise that local interests do not appear in national curricula, but as Benavot *et al.* notes “National characteristics are only weakly related to curricular emphases”(Benavot *et al.*, 1991: 97). The lack of true national curricula is due to the fact that we are all part of a globalised economy in which a few countries have a very disproportional influence. Benavot *et al.* (1991: 97-98) continues by illustrating how nations lack of self-determination to set their own education system has come to be the norm:

...the prescription of mass education is endemic, encouraged by international organizations, by professional elites, and by the dominant powers throughout the modern period. To some extent, the logic of mass education carries implications for a common cultural content (again emphasizing shared national culture and a good deal of rationalism). Finally, to some extent the mass curriculum is directly defined and

prescribed through the influence of international organizations (e.g., the World Bank and United Nations organizations), through the models provided by dominant nation-states, and the education professionals who operate on a worldwide basis. All these influences (which are difficult to distinguish empirically) find receptive audiences in national societies and states eager for legitimacy and progress...national identity in the modern world-system is achieved through conformity to the institutionalized ideals.

The World Bank and other international organisations are not the force of globalisation, but rather a product of the international trade-based economic system. From early globalisation in the Middle Ages, the system has fundamentally remained the same. The Roman Church was the dominant organisation that made the international laws of the time and enforcement was often the threat of heresy, which legitimised military conquest in the form of the Crusades (Ruhaak *forthcoming* 2017b). The trading economy developed wealth, which led to stronger militaries that could sustain longer battles, something subsistence economies have not been equipped to withstand. Thus, subsistence economies have largely disappeared and the international trading economic system has grown over the centuries to encompass the world. The domination of the knowledge economy of universities and the western education system no longer relies on the threat of heresy as the Church of the Middle Ages, but those that speak outside of the knowledge system have little voice on the world stage.

This push for unification of the knowledge economy has obvious profit incentives, but it is also the basis for the global economic trading system. Thus, institutions as the World Bank that have been instrumental in the recent push for a unified global knowledge economy that have been marginalising local knowledge of traditional subsistence economies:

Global educational discourses on the knowledge economy, lifelong learning, and human capital education are influencing the decisions of national policy makers. Research shows that most IGOs and NGOs, in particular the World Bank and OECD, are also supporting educational plans tied to the knowledge economy and human capital development.

English as the language of global commerce is making the teaching of English a fixture in most national curricula.(Spring 2008: 352)

The impact of this expanding knowledge economy has been profound (Spring 2008: 352). Knowledge of cultural geographies is quickly fading as languages that were tied to them disappear. Ethnologists are documenting as much as they can to try to preserve as much as possible, as the loss of these languages are disappearing at an unprecedented rate. Since the subsistence economies that these languages supported are no longer functioning, so too does much of incentive to keep the language a defunct economic system is based upon. Benavot *et al.* (1991: 98) summarises the situation for traditional cultures in the present context of globalisation:

Our period is one in which local and primordial cultures are undergoing wholesale destruction, in part as a result of mass education. Local languages die out or are circumscribed, as are local gods and spirits. Local political divisions are undercut, usually in the name of a national polity, along with parochial technologies and customs. Every aspect of the modern world-system builds conformity of economic, or political, or familial and cultural rules to regional, ethnic, or national standards.

VII. The *Y.pestis* Genome, its Characteristics and Environments that it has Flourished and Declined

1.20 Ecological Aspects of Survival of *Y.pestis*

Y.pestis has been shown to be able to survive in soils for long periods of time, maybe through the use of amoeba, which may explain the fact that Plague outbreaks often re-occur in the same location after years or even decades without any outbreaks (soil (Borsch, 2014:125-156; Bos *et al.*, 2016:1-11; Carmichael, 2014:157-192; Eisen 2008:1-14; Varlik, 2014:193-228). However, *Y.pestis* is much more fragile in this habitat and, unlike its ancestor, *Y.pseudotuberculosis*, soils are not its natural habitat and its survival over 40 weeks in previously ploughed and cultivated soil, but much shorter in forest soil (Ayyadurai *et al.*, 2008:2865-2871; Laudisoit, 2013). This may be due to the richer microbiome diversity in the forest soil, as Dirk van Elsas *et al.* (2012) explain “Soil microbial diversity is a key factor that controls the extent to which bacterial invaders can establish” (Dirk van Elsas *et al.* 2012:1160).

The ideal habitat for *Y.pestis* is on the blood of warm-blooded mammals, and it is

a generalist, being able to live in a variety of blood-dependent fleas, ticks, and lice (Ayyadurai *et al.*, 2010:892-893; Houhamdi *et al.*, 2006:1589; Laudisoit, 2007:687-693; Rossi *et al.*, 2013:505-506) as well as in mammals themselves. The ability of *Y.pestis* to survive in rodent populations while no disease outbreaks were documented was found by Ziwa *et al.* in Mbulu and Karatu Districts, Tanzania that had suffered previous Plague outbreaks. Ziwa *et al.* explain,

On the basis of (our) results we conclude that *Y. pestis* is circulating among others in *Mastomys natalensis* and *Gerbilliscus* sp. in Mbulu and Karatu districts; that the two rodent species are likely to be responsible for maintaining the pathogen during periods of no disease outbreak. Presence of the pathogen during the period of disease quiescence implies that continuing outbreaks should be expected whenever conditions become favorable and hence necessary preventive measures and emergency preparedness plans should be put in place. We noted that female rodents have a higher infection rate, a fact that may be taken into consideration when prioritizing infection control measures (Ziwa *et al.*, 2013:6).

Ziwa *et al.* found rodents with *Y.pestis* while no human Plague outbreak was reported, which highlights the capacity the pathogen has to survive, even when a society believes it is out of danger of becoming infected with the bacterium. The variety of hosts and vectors (organisms that spread an infection caused by pathogens) that *Y.pestis* can depend upon gives it a great amount of adaptability to survive, even though the pathogen will often be responsible for the death of the hosts (Eisen 2009:1-14). Easterday *et al.* note that for many pathogens, as *Y.pestis*, genome reduction will take place, eliminating genes that are not being used.

1.21 Biological evidence of *Y.pestis* and the Plague

Plague, a deadly zoonose caused by the bacterium *Yersinia pestis*, has been firmly documented in 39 historical burial sites in Eurasia that date from the Bronze Age to two historical pandemics spanning the 6th to 18th centuries. Palaeomicrobiologic data, including gene and spacer sequences, whole genome sequences and protein data, confirmed that two historical pandemics swept over Europe from probable Asian sources and possible two-way-ticket journeys back from Europe to Asia. These investigations made it possible to address questions regarding the potential sources and routes of transmission by completing the standard rodent and rodent-

flea transmission scheme. This suggested that plague was transmissible by human ectoparasites such as lice, and that *Y. pestis* was able to persist for months in the soil, which is a source of reinfection for burrowing mammals (Drancourt and Raoult, 2016:1).

Drancourt and Raoult illustrate findings of recent genomic studies of *Y.pestis*, which are fundamentally important to the methodology of the Black Death narrative. Their summary highlights the connection between epidemics spanning time and geographic regions and the ability of *Y.pestis* to persist in regions without plague outbreaks occurring, thereby calling into question when the pathogen arrived in Europe (which will be addressed below). The genomic mapping of *Y.pestis* developed the connection to modern outbreaks of the Plague to Black Death, as well as largely discrediting a fundamental belief in most historical narratives of the 14th century pandemic that the strain of the pathogen must have been an extremely virulent strain unknown today (Bos *et al.*, 2011:506-511; Cui *et al.*, 2013: 577-582; DeWitte *et al.*, 2008:1436-1441; Green, 2014:1). This finding forces narratives to find other reasons why the pandemic was so devastating, Bos *et al.* explain:

The Black Death is a seminal example of an emerging infection, travelling across Europe and claiming the lives of an estimated 30 million people in only 5 years, which is much faster than contemporary rates of bubonic or pneumonic plague infection and dissemination...although no extant *Y. pestis* strain possesses the same genetic profile as our ancient organism, our data suggest that few changes in known virulence-associated genes have accrued in the organism's 660 years of evolution as a human pathogen, further suggesting that its perceived increased virulence in history may not be due to novel fixed point mutations detectable via the analytical approach described here. At our current resolution, we posit that molecular changes in pathogens are but one component of a constellation of factors contributing to changing infectious disease prevalence and severity, where genetics of the host population, climate, vector dynamics, social conditions and synergistic interactions with concurrent diseases should be foremost in discussions of population susceptibility to infectious disease and host-pathogen relationships with reference to *Y. pestis* infections (Bos *et al.*, 2011:509).

Y.pestis of different geographies today and of the recent past is very closely related to the *Y.pestis* of Black Death. However, the medieval and the present-day bacterium come from the same origin (Bos *et al.*, 2011:506-511; Cui *et al.*,

2013: 577-582; Haensch *et al.*, 2010:5; Krause, 2016). Microbiological and Paleogenomic (ancient DNA studies) research has found that *Y.pestis* is identical to *Y. pseudotuberculosis* except for the gene gains or losses that result in its increased virulence (Hinnebusch *et al.* 2016:1932-1940; McNally *et al.* 2016:177-190; Shapiro *et al.* 2016:1-47; Zhou *et al.* 2009:2242-2250) . *Y.pseudotuberculosis*, which thrives in wet areas and lives in soil, (Eisen, 2008:941-943) has been determined to be the ancestral bacterium to the stable (relatively unchanging) *Y.pestis*. The changes in the ecology probably drove the evolution of *Y. pseudotuberculosis* into *Y.pestis* through the acquisition of virulence genes, which allow the *Y.pestis* to survive in the bloodstream of its host (an organism that supports and nourishes a parasite) and to be transmitted by fleas (Hinnebusch *et al.* 2016:1932-1940). This transformation has been thought to have occurred in Asia (Rasmussen *et al.* 2015:571-582).

1.22 Who died of the Plague during Black Death?

Based from skeletal evidence from London, DeWitte *et al.* further explains:

The Black Death (has) a tie of frequent, devastating famines. Population growth and simultaneous increases in taxes, rent and grain prices in the twelfth and thirteenth centuries created stark social inequalities, particularly with respect to food availability. Famine might have increased frailty, as least for people of lower socioeconomic status. Hazard and survival analysis of skeletal samples from London reveal decreased survivorship and increased risks of mortality and, by inference, declines in health in thirteenth century London compared with the eleventh and twelfth century. Declines in health and increasing populations and population connectivity via regional commerce before the Black Death might have contributed to extraordinarily high mortality levels during the epidemic (DeWitte 2016:2).

This frailty leading up to the mid-fourteenth century epidemic is held up by the contemporary skeletal evidence. DeWitte and Slavin observed that recent paleodemographic and paleoepidemiological evidence indeed shows that Black Death “killed selectively—similar in kind, if not in scale, to normal, nonepidemic causes of mortality—Targeting mainly older adults and frail individuals with a history of physiological stress” (DeWitte 2016:37).

Socio-economic System Links between Black Death and fatalities

The connection between wealth-creating, socio-economic systems and infectious disease epidemics is not particular to any region, but has been a worldwide phenomenon. Barrett and Armelagos (2013) illustrate this in their analysis of skeletal evidence of emerging infections:

We find ... associations (of societies with distinct socio-economic statuses positively related to signs of infectious disease) in the skeletons and graves of historical populations throughout the world (Armelagos et al. 2005; Paynter and McGuire 1991). Indeed, it is a story as old as human hierarchy, and one that continues to be told in the present day: people with greater resources tend to be relatively healthier than people with lesser resources. Societies having greater resource differences can be traced in prehistoric antiquity, they are not as old as humanity itself. Rather, they are the more recent results of the Agricultural Revolutions. Combined with declining nutritional quality, increasing population density, and proximity to nonhuman animals, these social changes brought the first major rises of acute infectious diseases in the human species (Barrett and Armelagos, 2013:41).

Barrett and Armelagos' observe that hierarchical societies with distinct socio-economic classes based on wealth are at distinctively higher risk than societies where the socio-economic wealth distinction between classes is more blurred. This theory is exemplified by the Gaels of medieval Ireland after the conquest and colonisation of Irish lands by the English in the period AD 1170-1250. The Gaels were able to re-take most of the island in the fourteenth century. Areas under Gaelic Irish rule were significantly less affected by Black Death than areas held by English colonists, but this resilience was probably not due to genetics, as subsequent outbreaks were not perceived to be easier on the Gaels. Furthermore, there were many Gaels who lived among the Anglo-Norman populace in the south and midlands of Ireland who were affected by plague. The regional vulnerabilities which impacted on the Anglo-Norman colony in the early and mid-fourteenth century may be due to the socio-economic system that led to ecological crisis, and subsequently malnutrition and a people's weaker immune systems, DeWitte *et al.* explain:

Dramatic transformations in society, triggered by the Black Death, may have occurred because progressive change had not been allowed or could not emerge because of intrinsic inertia in the system. Prior to the Black Death in Europe, economies were stagnating, feudalism prevailed and with it, according to Epstein (Freedom and Growth: The Rise of States and

Markets in Europe, 1300-1750. London), there was low investment in improving agriculture...The Black Death (has) a tie of frequent, devastating famines. Population growth and simultaneous increases in taxes, rent and grain prices in the 12th-13th centuries created stark social inequalities, particularly with respect to food availability, in the pre-Black Death population. Famine might have increased frailty, at least for people of lower socioeconomic status. Hazard and survival analysis of skeletal samples from London reveal decreased survivorship and increased risks of mortality and, by inference, declines in health in 13th century London compared with 11-12th century. Declines in health concomitant with increasing populations and population connectivity via regional commerce before the Black Death might have contributed to extraordinarily high mortality levels during the epidemic (DeWitte *et al.*, 2016:2).

Black Death narratives have often claimed that it killed a third to up to two-thirds of Europe in the mid-14th century, but as DeWitte *et al.* illustrate these generalisations may indeed gloss over what may have been responsible for certain population's heightened vulnerability. Recently there has been a great deal of research on *Y.pestis*, the causal pathogen for the Plague, which can heighten our awareness of factors of vulnerability and resilience to more accurately assess the level of risk for an epidemic of different societies to better understand why some disproportionately survived and others did not.

1.23 Who survived Black Death

Black Death was not an example of indiscriminate death, some people survived quite well. Actually in China there is very uncertain evidence if a medieval plague epidemic even took place there. In Europe, Poland may serve as a similar example as places where agriculture and herding took place, but there is a lack of evidence to show that this was a catastrophic time. One reason may be due to the great dependency upon grains that do well during very wet periods, rice and millet. Both of these grains were very popular in China, but only millet was common in Poland.

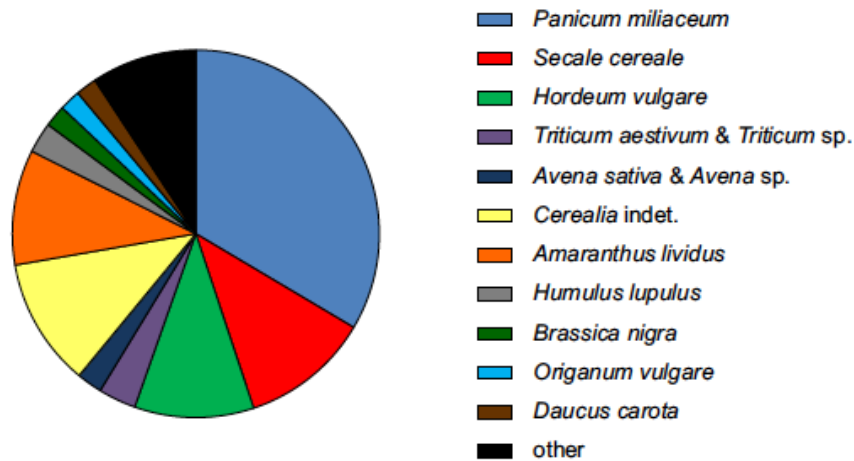


Fig.1.4. Percentage of Plant Macro-remains of different cultivated and probably cultivated plants of medieval Kraków, Poland (Mueller-Bieniek, Walanus, and Zaitz, 2015:101).

Panicum miliaceum (millet) was the most cultivated crop in Kraków, Poland, which is certainly eye-catching, as this is very unusual in medieval Europe (though was also seen in some areas of the Baltic states, as Lithuania). Since, millet, unlike other European grains as wheat, oats, barley and rye, would have greater yields in a very wet environment, whereas typical European cereals would struggle to survive. If early-mid fourteenth century Europe was indeed a wet period, then most of the agriculture would have struggled, whereas Poland's agricultural yields may have done substantially better than their other European counterparts. Their heavy dependency upon millet may have kept their agricultural system going when others collapsed. Thus there would not have been such a need to dramatically increase their dependency upon animal husbandry as commonly seen throughout most of Europe.

The other groups that have done especially well were especially mobile, as the Gaels of Ireland and the Bedouins of the Mamluk Empire. The Gaels and the Bedouins being less connected to the centralized, hierarchical bureaucracies that organised the trading economy of scale than their permanent settler counterparts increased their resiliency. Ruhaak (2017) explains,

The centralisation of large bureaucracies in Europe and the Middle East increased with the onset of the Crusades, which brought much social organisational, economic, ecological/biological, demographic, and intellectual change with it. The Gaels and the Bedouin though under these

centralised powers, were not as controlled by them. Both these peripheral groups are characterised by their lack of defined way of life as both groups were involved along the spectrum from settlement agriculture to the mobile raiding herders. The relative adaptability of the more de-centralised Gaels and Bedouin allowed them to survive and expand in times of crisis, as during the Black Death (Ruhaak, 2017:1).

The Medieval Church created Europe as a cultural and economic geographic entity for the first time. The Church's orchestration of the Crusades brought about socio-economic organisation on a large scale. The Crusades as a large-scale military operation forced a focus on wealth creation through the creation of agricultural surpluses and long-distance trade to attempt to maximise the potential wealth creation. The commodities concentrated upon were those that could garner premium market prices. Therefore, landscapes were transformed through deforestation and clearance of vegetation in order to maximise the potential agricultural production. Ecological systems were simplified to focus on cereal and livestock feed production as well as grasslands for grazing. The Bedouins and Gaels were connected to this socio-economic system to varying degrees. Some Bedouins and Gaels were permanent settlers like their common counterparts in Europe and the Mamluk Empire, while from the late thirteenth century an increasing minority had greater mobility and gained needed resources through different sources, as farming, herding, hunting and gathering, trade, and raiding. The Bedouins and Gaels had great networks and alliances that were often in a state of flux, giving them access to resources and support in different regions. The importance of this relatively de-centralised organisation was not only seen with the Gaels and the Bedouin, but also has been seen with the early Ottoman (Schamiloglu, 2004:270-272) as well as the Scandinavians of central Sweden. Ersgard explains how the breakdown of the feudal system in central Sweden led to greater decentralisation and adaptability to survive Black Death much more successfully than their southern counterparts:

The new situation around 1350 – the old manorial system being in dissolution and old social bonds between landowners and peasants breaking up – may have provided the latter a greater freedom to act on the local level. Probably we should look upon the rapid development of survival strategies at the farmsteads in the light of this new freedom. Thus the essential, societal conditions for an independent acting of the peasants were already in place in the middle of the fourteenth century.

Developing their strategies, they could respond immediately to the crisis, which further hastened the social process (Ersgard,L. 2016:99).

The lack of dependency upon a hierarchical, centralised agricultural system would have allowed the peasantry to adapt based upon their observations of the ecologies they depended upon in order to meet their own needs. A centralised system that requires peasants to pay substantial taxes or risk physical consequences by the hand of authority would have forced them to focus on the production of wealth through commodities of higher market value. Secular and ecclesiastic leaders feared neighbouring powers and therefore demanded much from their peasantry in order to augment their wealth to increase their security through investing in the military, defensive structures (as city walls and castles), and infrastructure to assist economic production and trade. Thus, the sustainability of ecosystems became relatively expendable in the context of fear of short-term survival. It is in this context that the vulnerabilities for the Plague pandemic were born.

VIII. Rethinking Black Death

1.24 Retracing the presence of *Y.pestis* in the Eurasian Ecology

Researchers of Black Death have, with rare exception, believed that *Y.pestis* spread across Eurasia and northeast Africa incredibly quickly, intensely, and extensively during the pandemic. Most researchers consider that the whole region was blanketed by the pandemic or only briefly mention areas that seemed to have largely escaped the disease. It was said to be spread via trade routes, but the trading economy had been faltering since the late 13th century, with ruinous famines, cattle and sheep pandemics, and dramatic price inflation leading up to Black Death (a sign of much greater demand than supply) (Campbell ,2007; Campbell 2010:281-314; Campbell, 2008:896-945; Dodds, 2007). Few would have been able to afford the growing cost of grain, and the French and English kings tried in vain to control prices (Kaye 1998:24-27).

1.25 The question of survival of *Y.pestis* from the Justinian Plague, the fall of the Roman Empire, and its re-emergence in Europe

Y.pestis has had some history in Eurasia and northeast Africa, as it was present in

the form of the epidemic, the Justinian Plague at the end of the Roman Empire (Wagner *et al.*, 2014:319-326). After the fall of Rome, the trading economy deteriorated and so did agricultural cultivation, leaving the ecosystems the opportunity to grow in biological intensity and complexity. This period of reforestation led to fewer fragmented forests and edges, and lower livestock and human population densities. As McMichael, Begon, and Lauderisoit risk factors of a zoonotic epidemic noted earlier stated, this is not the environment that *Y.pestis* seems to thrive in (Eisen & Gage 2008:5). As the ecology changed within the former Roman Empire, the capacity of *Y.pestis* to survive may have been limited, as it is “very genetically monomorphic” (Keim and Wagner 2009:816) meaning that its capacity to adapt to environmental changes has been limited. Keim and Wagner below explain, long-range expansion of a pathogen, as *Y.pestis*, may not require much adaption if the ecological conditions are similar to its origin:

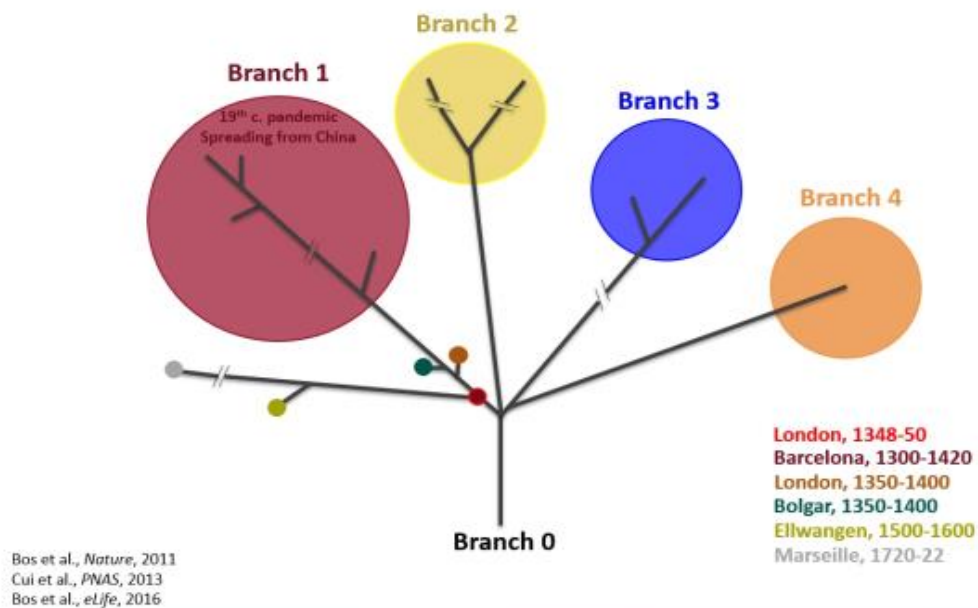
...long range dispersal events, coupled with adaptations for dispersal, provide pathogens with access to naïve host populations, which is a great fitness advantage for the fortuitous clones. As these new areas may contain similar ecologic conditions to the ancestral regions, pathogens invading these areas are not necessarily occupying completely novel niches but rather occupying the same or similar niches to those found in the ancestral regions. These areas can be thought of as open niches, as the pathogens of interest did not previously have access to these locations and they were unoccupied by other pathogens (Keim and Wagner 2009:820).

The standardisation of markets in a trading economy lead to cultivating the same species or closely related species (i.e. wheat, sheep, and cattle) throughout a trading region, creating “similar socio-economic conditions” within the economic zone. These similar socio-economic conditions would have included large, domesticated herds under the same roof as peasants and agricultural labourers (Pluskowski, Boas, and Gerrard 2011:192-225). Wildlife adapted to ecological services that resulted from human impact (e.g. rodents with cereal cultivation) and the increased demand for intensive labour, leading to greater human population densities. Consequently, an argument can be made that as the Roman Empire declined and with it the trade-based economic system that depended upon cash-crop agriculture and domesticated animals, the dramatic ecological change that resulted may have been too extreme for *Y.pestis* to adapt to.

Accordingly, Eurasia remained relatively free of epidemics until after the trading economy established itself again, and its rapid expansion during the early Crusades. It has been suggested that *Y.pestis* entered Europe through Spain as early as 1300A.D. (Spyrou *et al.*, 2016:875-878) and contemporary written sources show that the Plague appeared within the Mamluk Empire stretching from present-day Syria to Egypt in 1346, before it came to Europe. Spyrou *et al.* (2016) suggest that the radiation event, a polytomy (simultaneous or nearly simultaneous genetic divergence of multiple lineage branches) (Hymes, 2014:285), sometimes called the “Big Bang” of *Y.pestis* may have started in Europe before the Pandemic started:

The disease is thought to have arisen from plague foci in East Asia and to have spread into Europe via trade routes. Its origin, however, is still contentious due to a lack of convincing archaeological or documentary evidence from the early 14th century in East Asia (Sussman, 2011). Ancient *Y. pestis* genomes obtained from medieval victims have indicated the presence of a radiation event immediately preceding the Black Death that gave rise to most of the strain diversity circulating in the world today (Spyrou *et al.*, 2016:874).

While there is strong evidence to show the origin of *Y.pestis* that would cause Black Death was in the region of the Qinghai-Tibet Plateau (Branch 0, see below), there is no convincing documented evidence of a fourteenth century epidemic in China or India (Sussman, 2011:319). There are significant genomic differences in the DNA of *Y.pestis* of the Justinian Plague and Black Death that show they are not coming from the same DNA strain, but many outbreaks since are or are very closely related to *Y.pestis* of Black Death. Krause summarises Bos *et al* 2011, Cui *et al* 2013, and Bos *et al* 2016 studies in the genome diagram below:



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Fig. 1.5. Krause's diagram illustrates the *Y.pestis* "Big Bang" that led to different mutated strands of the bacteria that took place sometime before Black Death (Krause suggests in the thirteenth or early fourteenth century) to the present. Krause explains, "Branch 1 is the lineage responsible for both the Second (medieval) Pandemic in western Eurasia and Africa and the Third (modern, global) Pandemic." Branches 2,3, and 4 were much less extensive in longevity and geography. (<http://eccmidlive.org/#resources/ancient-pathogen-genomics-what-we-learn-from-historic-pandemics>)

Branch 1B (the red-darkened circle strain) of *Y.pestis* is found in DNA testing of victims of Black Death as well as modern epidemics as 19th century China and recent outbreaks in East Africa (Cui *et al.*, 2013: 577-582). Krause notes that about 90% of the *Y.pestis* strains of modern day plague outbreaks are from the Black Death lineage, including outbreaks with lineage to the Third pandemic in 19th century China (<http://eccmidlive.org/#resources/ancient-pathogen-genomics-what-we-learn-from-historic-pandemics>) Krause's diagram shows that branch 1B of *Y.pestis* mutated to its present strain significantly before Black Death and the same genomic branch has continued to survive ever since. *Y.pestis* has been known to adapt to dramatically altered areas, particularly extensively deforested and cultivated areas (Neerinchkx, 2010). Evidence of this

vulnerability was not limited to the coming of the Plague. Famine and infectious diseases started to become more prevalent from the twelfth century (i.e. parasite diseases, tuberculosis, and mycotoxin poisoning from fungi in cereals) (Crawford, 1989:116-117; Graham, 1927:342; Lee, 2009:179-184; Matossian, 1991; Wong 1951).and their domesticated animals as cattle and sheep murrain (Newfield 2009:155; Slavin 2012:1239-1266).

1.26 *Yersinia pestis* and the 'Big Bang' Hypothesis

It is been documented that *Y.pestis* can survive in fleas, rodent populations, carcasses and soils, especially when added by free-living amoebae for long periods of time (though not necessarily by staying in the same reservoir) (Ayyadurai *et al.* 2008:2865-2871; Benavides-Montaño and Vadyvaloo 2017; Richgels *et al.* 2016). Benavides-Montaño and Vadyvaloo illustrate this hypothesis of multiple reservoirs to explain how *Y.pestis* survives so long between Plague outbreaks.

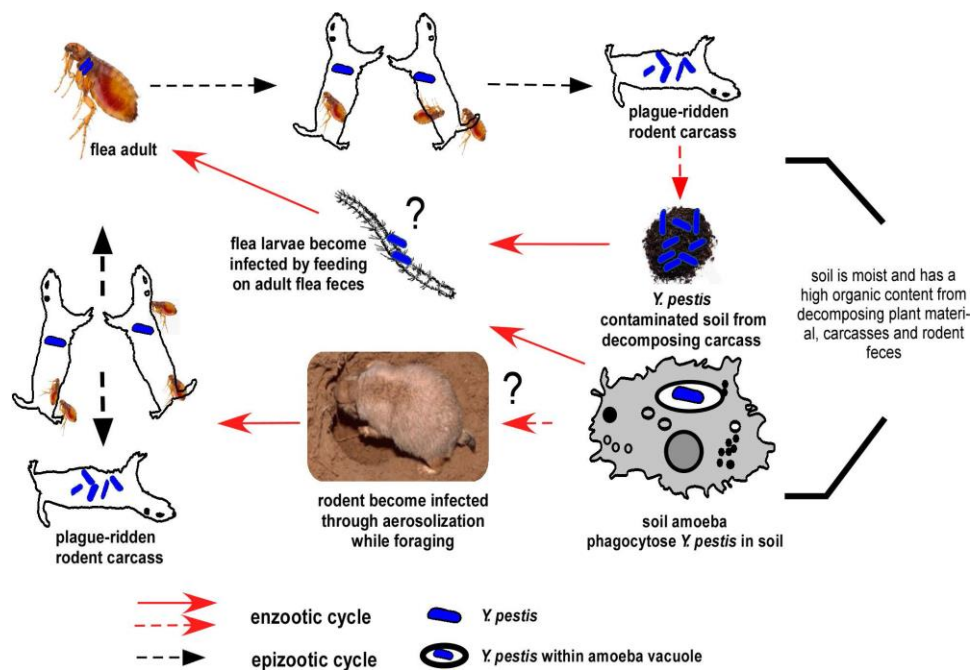


Fig.1.6. Benavides-Montaño, J.A. and Vadyvaloo, V (2017:40) example scenario of how *Y.pestis* survives when a Plague epidemic is not present in human populations.

This adaptability of *Y.pestis* to change reservoirs may be key to the fact that plague outbreaks often re-occurs in the same location after going without any outbreaks for years or even decades (Borsch 2014:125-156; Bos *et al.* 2016:1-11; Carmichael 2014:157-192; Eisen 2008:1-14; Varlik 2014:193-228). However, *Y.pestis* is much more fragile in this habitat and, unlike its ancestor, *Y.pseudotuberculosis*, soils are not its natural habitat and its survival is much more limited. Though *Y.pestis* has been documented up to 40 weeks in previously ploughed and cultivated soil, its lifespan is only around a day in forest soil (Ayyadurai *et al.* 2008:2865-2871; Laudisoit 2013), though amoebae and microbiota diversity (or lack thereof) may play an important role in the length of its survival in these environments (Benavides-Montaña and Vadyvaloo 2017, van Elsas *et al.* 2012:1159). The ideal habitat for *Y.pestis* is insects – fleas, ticks, and lice – that live on the blood of warm-blooded mammals (Ayyadurai *et al.* 2010:892-893; Houhamdi *et al.* 2006:1589; Laudisoit 2007:687-693; Rossi *et al.* 2013:505-506) as well as in mammals themselves. The variety of hosts and vectors (organisms that spread an infection caused by pathogens) that *Y.pestis* can depend upon gives it a great amount of adaptability to survive, even though the pathogen will often be responsible for the death of the hosts (Eisen 2009:1-14).

A trigger event of already present *Y.pestis* bacterium that would set off Black Death would help explain the often acknowledged but rarely addressed problem of the incredibly quick spread of the plague across Europe in a year or two, where the rate of geographic expansion has spread relatively slow in more recent outbreaks (Ruhaak *forthcoming* 2017A). Carmichael makes an argument that the Alps may have been a region where many potential host populations and potential reservoirs (any organism, soil, or substance that a pathogen normally lives and multiplies without injury to reservoir host or the pathogen) existed for *Y.pestis* to survive within and was responsible for the periodic plague epidemics that often recurred every few decades after Black Death (Carmichael 2014:157-192). Ruhaak *et al.* (*forthcoming* 2017A) argues that *Y.pestis* may have been present in Europe, Western Asia, and North Africa from the time of the Mongol

Invasions. Thus, maybe we should not assume that *Y.pestis* was distributed throughout the region right before Black Death.

Anthropogenic land cover changes as deforestation, clearance for agriculture, introducing the same plant and animal species to an expansive area could have extended the habitat area for *Y.pestis* by altering networks of interdependent organisms and the dynamics that organisms (as humans) were interacting with other organisms. This potentially would have been the opportunity for a pathogen, as *Y.pestis* to go from one mammal host (e.g. a rodent) to a human host.

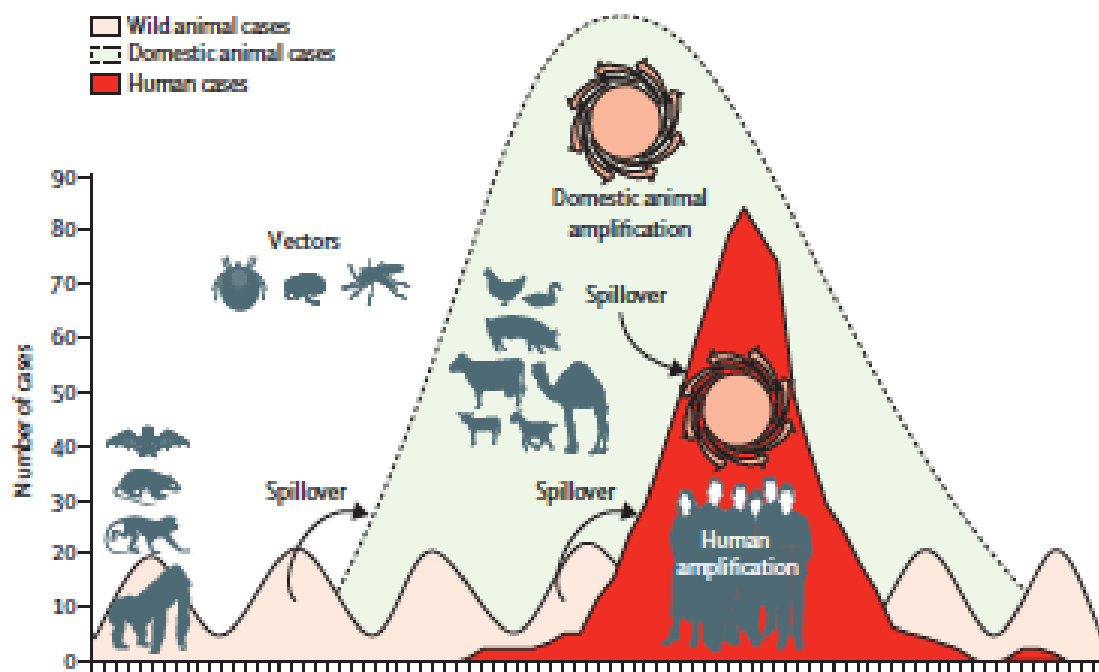


Fig.1.7. Karesh, *et al.* (2012: 1942) illustrate the common routes of transmission of zoonotic disease in human populations. They explain the diagram of a transmission of zoonosis disease “of infection and amplification in people (bright red) occurs after a pathogen from wild animals (pink) moves into livestock to cause an outbreak (light green) that amplifies the capacity for pathogen transmission to people”

The trading economy of Eurasia and Northeast Africa diminished differences among many habitats as market demands led to similar networks of

interdependent organisms and their interaction dynamics could have taken place with the large herds of domesticated animals and cereals being produced. These species introductions (along with land cover changes) would produce new environmental niches with less competition and threat of predation, allowing quick breeding opportunistic species a chance to thrive. This would seem to be an ideal situation for *Y.pestis* and its potential hosts to thrive. Archaeologists have described the long existence of ‘transported landscapes’ that have resulted in many unintended introductions including commensal and parasitic species (Biovin *et al.* 2016:6391,3692). Many unintended species introductions have followed intended foreign species to these new lands, and these unintended species would include weeds, rodents, insects, and pathogens.

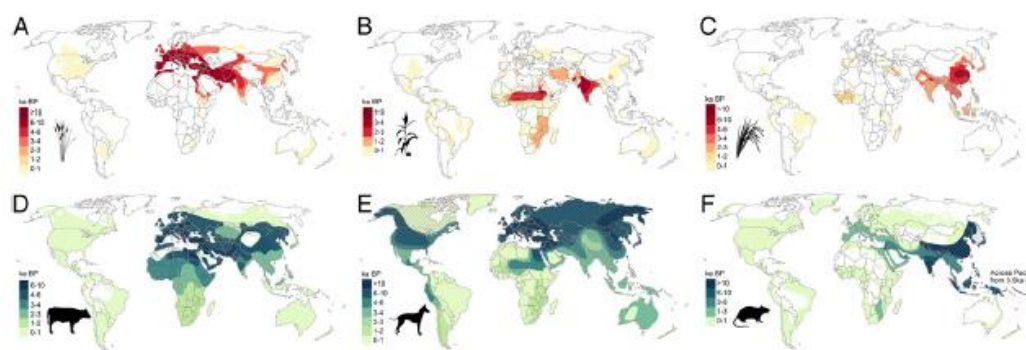


Fig.1.8. The global spread of (A) wheat, (B) Sorghum, and (C) Rice, (D) Cattle (*Bos Taurus* & *Bos indicus*), (E) Dog and (F) different rat species (*Rattus rattus*, *Rattus tanezumi*, *Rattus norvegicus*, *Rattus exulans*) through time (Biovin *et al.* 2016: 6391)

The most established area of (A) wheat and (D) cattle seem to occupy the same region of the Justinian plague and Black Death, though these areas are difficult to strictly define. This systematically changing the landscape during the middle ages within the Eurasian and northeast African regions would have climaxed at the height of the trading economy with western China in the mid to late thirteenth century (Sussman 2011:328-329; Norris 1977:1-24). It is also important to note that landscape cover changes associated with large-scale

agriculture, which requires deforestation and clearance of wild vegetation, are the prime indicators for regional climate change (Findell *et al.* 2009:3266-3267).

Turning back to the matter of vulnerability in Europe and the eastern Mediterranean, poor harvests are recorded in the late thirteenth and early fourteenth centuries (Farmer 1988:787-817, Dols 1977), after the period in which *Y.pestis* might have reached Europe. The period from the late 1260s to the mid-1330s represents about three generations where a food shortage existed, which would have meant that they had a greater likelihood of malnutrition and subsequently more susceptible to disease than earlier in the thirteenth century. Poor harvests returned in the mid-1340s (Campbell 2000:6, Dols 1977). Yet, it seems that, at a minimum, for *Y.pestis* to spread so thoroughly and rapidly across the European and English population in 1348, as well as Ireland a year later, a vibrant trading economy would have been necessary to be able to transmit this disease to an unprecedented degree. Such an economy may have existed to some degree during those years of poor harvest, and yet there was no rapid and significant spread of *Y.pestis* until the 1340s. We must speculate, then, that it was the period of the late 1330s to the early 1340s that saw *y-pestis* spread as a large-scale pandemic around regional areas thanks to a trigger incident. Such an event may have been the flooding and the large-scale flooding, precipitated by the dramatic deforestation and the expansion of agricultural fields and grazing lands in central Europe, as Dotterweich (2013) illustrates below:

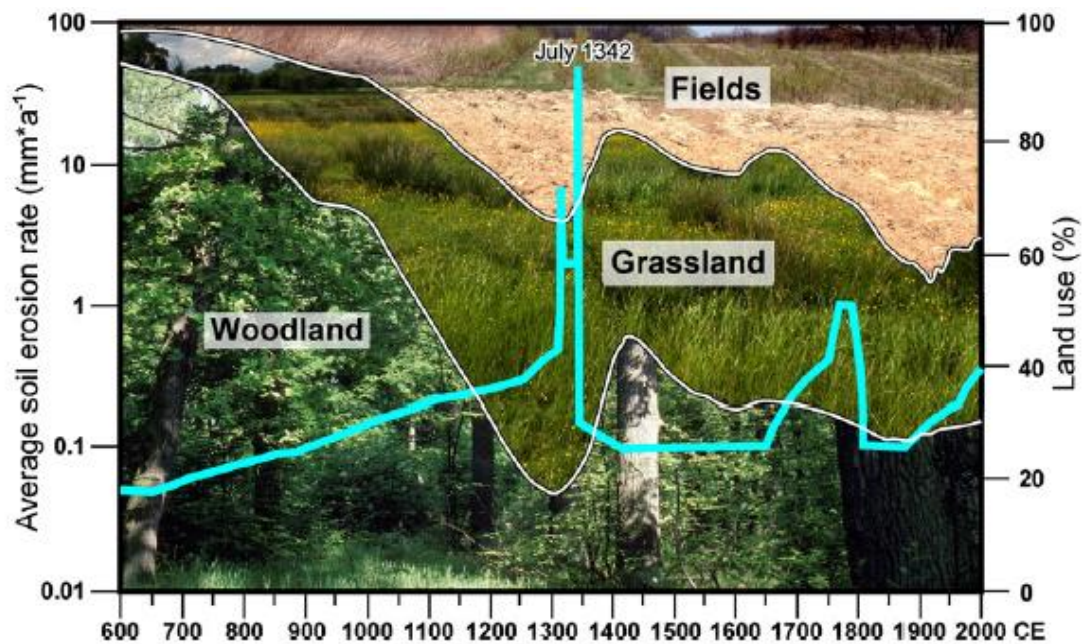


Fig.1.9. Soil erosion [light blue line] and land use change in central Europe since 800 CE, which shows the peak erosion period on the eve of Black Death (Dotterweich 2013:4).

Overly wet soil and flooding, both consequences of climate change, have been shown to be significant factors in the spreading of many infectious disease pathogens as well, as a cause of killing or diminishing plant and tree growth. (McMichael 2004:1049-1058) This may be found to be especially important in the development of plague epidemics as *Y. pestis* has been found to live in soils and is evolved from *Y. pseudotuberculosis*, a bacterium that thrives in wet areas, and often lives in soil (Eisen *et al.* 2008). *Y.pseudotuberculosis* tends to thrive in colder environments in Asia and potentially could have come over with the Mongolians and remained in colder areas as the Alps. Cui *et al* (2013) argue that the simultaneous or nearly simultaneous genetic divergence of multiple lineage branches (the 'Big Bang') that yielded most of the current strains of *Y.pestis* took place between 1142 and 1339 (Cui *et al* 2013:580; Harbeck *et al.* 2013;Hymes 2014:293) They also tracked the bacterium origin to the region of the Qinghai-Tibet Plateau (Cui *et al* 2013:580).

It is typically hypothesised that *Y.pestis* was solely brought over by trade from China in the mid-fourteenth century. However, as Philips notes of this period, 'the actual volume of the eastern trade was surprisingly small' (Philips 1998:97-

98). Could such a small trade link be held as the smoking gun for the pandemic that is said to saturate Eurasia, and to have reached Ireland, in a few short years? It is unlikely. We should entertain instead the idea that *Y.pestis* was regionally present *before* the Black Death. We ought to consider the possibility that the Mongolians brought *Y.pestis* to western Asia and Europe in the early-to-mid thirteenth century.

1.27 Establishing Risk for Populations during Black Death

The fourteenth century has been cited as a time of resurgence for different nomadic and semi-nomadic groups which experienced territorial growth, such as the nomadic Bedouins of Egypt, the rise of the largely nomadic Ottoman over Turkish principalities of western Asia and south-eastern Europe and the nomadic Arabs in the Arabian peninsula (Schamiloglu 2004: 270-272). The areas taken over were settled, urban territory occupied by agricultural, cash-crop intensive, trading settlers, whom these nomadic peoples may have indeed have had ecological advantages over in terms of defences against infectious disease. This connection of the environment to infectious disease is far from a new belief as Ruth Meserve explains:

...nomadic use of pastures in Central Eurasia has been closely tied to traditional shamanic folk medicine. It relates to geographic space and to the distribution of natural resources and disease areas. Mental maps show that infection paths (of Black Death) are localised and boundaries and spatial markers are put up against the spread of disease, combining empiric and cosmologically defined spaces. Also, nomadic etiology in many cases infers disease from 'dead land' (*körös ügei*): pasture that has 'lost its skin' through building, farming, etc. (Meserve 2010:2)

This phenomenon can be seen among many peoples who lived sustainably within their cultural geography in a substance economy (see the first chapter's section on Tanzania, p.50). The core foundation of any society and culture is to provide the basic needs necessary for survival. These necessities of food, drink, and the resources for clothing and shelter from the elements could be extracted from a people's own surroundings or imported from foreign ecosystems. The less foreign imports are depended upon by a people, the more crucial

sustainability of local ecosystems would become for the continuation of basic needs for years and generations to come.

Starting in the twelfth century, Ireland was going through a transition period with the emergence of many monasteries and the Anglo-Norman agricultural economic system based in international trade. The degree and severity of this transition would vary from region to region, which studying the environmental evidence can highlight. The relevance of environmental evidence will be seen in this work by reviewing circumstances leading up to the Black Death of the fourteenth century and by tracing evidence through different disciplines based upon a foundation constructed through the ecological and corresponding economic record of change.

Dr. Tim Brooks from Public Health England (a Department of Health agency) and his team working with Archaeologist Jay Carver believe poor health (malnutrition, rickets, anaemia, and back damage, from heavy labour, was found in bone evidence of victims of Black Death in 1348) helped promote a pneumonic version of the plague (Russon 2014). The thought of a pneumonic plague ultimately being responsible for Black Death has an earlier precedent as a recent discovery of the earliest known plague caused by an *Y. pestis* strand almost 6,000 years ago, found no evidence that the bubonic plague was possible at that time, rather just the pneumonic and septicemic plague, which also would have been passed person to person, would have been present (Rasmussen 2015: 575).

It is also known that the bubonic plague (caused by the *Yersinia pestis* bacteria) in rodents often does not correspond with a human outbreak. Duplantier, Duchemin, Chanteau, and Carniel's research on *Yersinia pestis* carrying rodents emphasizes this point, "The importance of these socio-economic factors is clearly illustrated by the current situation in the United States, where natural plague foci in rodents cover practically the entire western third of the country and yet the annual number of human cases is very small" (Duplantier, Duchemin, Chanteau and Carniel 2005: 444). This phenomena is also seen recently in Madagascar, which has been faced with a human outbreak of bubonic plague, "In the Isotry district (one of the largest markets), where transmission of *Y. pestis* among

rodent populations is the highest (seroprevalence>80%), the situation appears paradoxical with very few reports of human cases and no observable epizootic (epidemic disease transmission from rodent to human)" (Duplantier, Duchemin, Chanteau and Carniel 2005: 444).

Graham Twigg has suggested that some epidemics labeled "plague" could not have been bubonic plague. Even in 1348-1350, supposedly the time of the worst bubonic plague epidemic, some observers reported necrotic and hemorrhagic symptoms that would indicate not plague but an immune-deficient condition. Furthermore, a poisoned food supply could have increased the incidence of plague in other ways besides weakening humans' resistance to infection. Mycotoxins in the *rats'* diet may have been just as damaging for an increase in rat deaths may increase the number of plague-infected fleas tapping human beings in place of their former hosts. (Matossian 1991:48)

Though we do know through DNA evidence that *Yersinia pestis* was present during Black Death, the unknown is why so many people died so quickly.

Though *Y. pestis* was present, we don't know to what extent. Biologically, the historical account of the black rat and the flea rapidly and thoroughly spreading an incredibly lethal disease is not well accepted, as Dr. Brooks recently stated: "As an explanation for the Black Death in its own right, [bubonic plague spread by rat fleas] simply isn't good enough. It cannot spread fast enough from one household to the next to cause the huge number of cases that we saw during the Black Death epidemics" (Russon 2014).

Adger tackles the question of what is social resilience and came up with the following:

...social resilience is defined as the ability of communities to withstand external shocks to their social infrastructure. This is particularly apposite for resource-dependent communities where they are subject to external stresses and shocks, both in the form of environmental variability (such as agricultural pests or impacts of climatic extremes), as well as in the form of social, economic and political upheaval (associated with the variability of world markets for primary commodities, or rapid changes in property laws or state interventions). (Adger, 2000:361)

Adger's definition of social resilience ties to der Leeuw's points on 'What drives socio-environmental systems regularly towards a crisis?', as Adger notes that "resource-dependent communities where they are subject to external stresses and shocks, both in the form of environmental variability...as well as in the form of social, economic and political upheaval..." Here Adger addresses the society's ability to correctly read the ecosystems they depend upon in terms of outputs of ecosystem services under various environmental and climatic stresses, as well as the society's ability to adapt and act with the changes that they observe in the ecosystems. Vulnerability increases as the range of resources depended upon narrows, as Adger illustrates, "One key factor of the economic aspects of resilience is in the nature of economic growth and the stability and distribution of income among populations. Dependency on a narrow range of resources can increase the variance of income and hence decreases stability." Economic growth based upon a narrow band of resources, leads to increases in populations and bureaucracies as well as organizational complexity. Accordingly, this ties to Tainter's premise that increased organisational complexity is inversely related to, as Adger describes it, "the ability of communities to withstand external shocks to their social infrastructure."

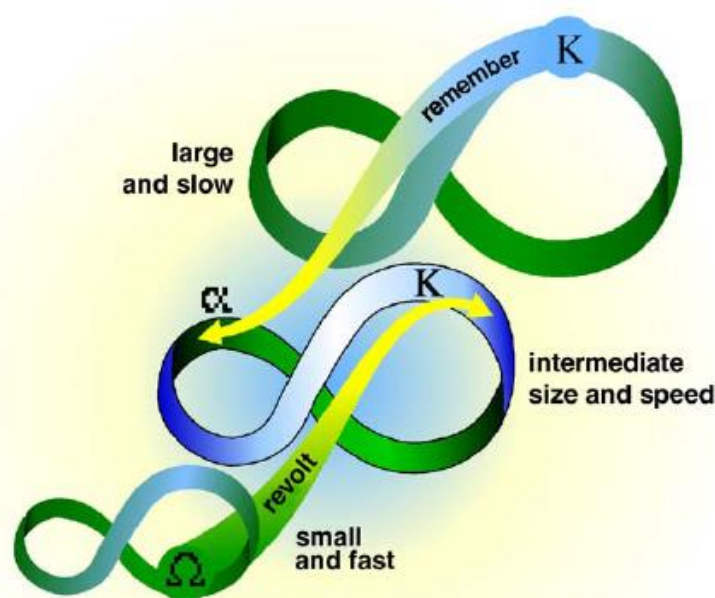


Fig.1.10. Folk model of Panarchy is “a heuristic model of nested adaptive renewal cycles of different sizes and rates of renewal that emphasizes cross scale interplay” (Folke, 2006:258).

Tainter’s (1990:264) *Four Concepts that Lead to Understanding Collapse*, are also intrinsically bound to social power and the way it filters through the organisational structure. If there is a lack of authority of those that directly deal with the problem, then for each level removed from the problem, the greater risk of error due to the filtering down of information and a lack of perception regarding the potential consequences of actions. Mann explains this social power distribution of institution through a five stage process:

- 1) “An egalitarian society” does not institutionalise hierarchical differences and “those in higher positions cannot lay their hands upon collective power resources.”

- 2) “Rank societies are not egalitarian...(and) may be institutionalized and even transmitted hereditarily into an aristocratic lineage. But rank depends almost entirely upon collective power, or authority, that is, legitimate power used only for collective purposes, freely conferred and freely withdrawn by the participants. Thus high rankholders have status, make decisions, and use material resources on behalf of the whole group, but they do not possess coercive power over recalcitrant members and cannot divert the material resources of the group to their own private use and so make it their “private property.

- 2a) In relative rank societies, persons and lineage groups can be ranked relative to each other, but there is no absolute highest point of the scale. In most groups, moreover, sufficient uncertainty and argument exist for relativities to be ultimately inconsistent with one another. Rank will be contested.

- 2b) In absolute rank societies, an absolute, highest point emerges. A chief or paramount chief is accredited uncontested highest rank, and all other ranks’ lineages are measured in terms of their distance from his. This is usually expressed ideologically in terms of his descent from the ultimate ancestors...So one characteristic institution appears: a ceremonial centre,

devoted to religion, controlled by the chief's lineage. From this centralized institution onward to the state is only a step.

3) ...The state is a differentiated set of institutions and personnel embodying centrality, in the sense that political relations radiate outward to cover a territorially demarcated area, over which it claims a monopoly of binding and permanent rule-making, backed up by physical violence. In prehistory, the introduction of the state converts temporary political authority and a permanent ceremonial center into permanent political power, institutionalized and routinized in its ability to use coercion over recalcitrant social members as necessary. (Mann, 2012:37-38)

The amount of flexibility and adaptability that people have in each of these societies decreases as centralised power increases and hierarchical control tightens. Many Gaels and Bedouin leading up to Black Death in the mid-fourteenth century would have been in Mann's "relative rank societies", particularly in Ulster and the Mamluk frontier, respectively. These people may have been displaced and part of more centralised socio-economic systems before, but after the English colonial expansion in Ireland and the Mamluk Empire over frontier lands as Jordan, some may have left the cash crop economy and went into a more de-centralised organization after crop yields went down and raiding by the Gaels and Bedouin became more frequent. It seems evident with all the support that the Bruce Invasion of Ireland received in the North in the early fourteenth century depended upon the forest for at least a significant part of their diet, became more mobile, and may have become a mercenary and/or raided and resisted against those in the manorial economy. Similarly, the Bedouin grew larger as former agricultural settlers grew in numbers, while the Mamluk government had its financial base diminished from declining agricultural production. Meanwhile, the Bedouin and their followers were similar to the Gaels as they had a variety of resources to draw from to sustain themselves including their livestock, wild animals, as well as the cultivated and wild fruits of vegetation. Walker illustrates this Bedouin adaptability during times of instability,

....In textual sources their mobility is regularly noted, with complete abandonment, however temporary, of settlements in times of political trouble (Mongol invasions, amiral rebellions, civil war), environmental disasters (floods, droughts, earthquakes), and economic hardship (grain scarcities, high food prices, unbearable tax burdens) (Walker, 2014:118).

The Bedouin adaptability allowed them to thrive during times when most settlements of the Mamluk Empire struggled. This increased risk for the Mamluk peasantry and the agricultural labourers are exemplified in Mann's last two stages of social power as the necessities of life are given or withheld through the legitimized hierarchal authority. Mann's stages of social power continue:

4) Stratification involves permanent, institutionalised power of some over the material life chances of others. Its power may be physical force or the ability to deprive others of the necessities of life...it is usually a synonym for private property differentials and for economic classes...

5)...(C)ivilization combines three social institutions, the ceremonial centre, writing, and the city. Where combined they inaugurate a jump in human collective power over nature and over other humans...(Mann, 2012:37-38)

The amount of control over nature is key for a government to quickly grow wealth, as agricultural production was the engine of wealth production. The support of this process through education (which fostered greater administrative control through law and accounting) and a justice system that the sultan, king, and Pope developed and headed over for their own interests, which a rule of law legitimised, funnelled resources and labour for their benefit. However, the centralised control of this hierarchical bureaucratic system which the Church, and the English kingdom, and the Mamluk Empire employed also led to a diminished connection to ecological realities.

1.28 Case Studies on the Plague and Black Death

The chapters which follow comprise a series of case studies. The case studies were chosen strategically in order to assess socio-economic and ecological changes in the region where the "Big Bang" of *Y.pestis* has been thought to

originate. From this point two other medieval sites were chosen that represent marginal sites in the mainstream trading economy in Europe and the Mamluk Empire. The case study sites were Ireland and Jordan and its outlying areas in the Mamluk Empire. These sites were part of centralised administrations (Ireland with England and the Church and its orders, and the Jordanian region with the Mamluk Empire with Cairo as its capital). However these lands marked the outer limits of control of these centralised powers, which was an unstable frontier that also consisted of more de-centralised network organisations of the Gaels of Ireland and the Bedouin of the Mamluk Empire. The Gaels and the Bedouins were terms used by the colonists to describe those that were previously outside of the centralised power's control. These marginalised people used local languages and customs and their activities were more linked to herding and warfare, but were part of a large socio-economic spectrum where most were at least part of the mainstream trading economy,. However, the majority of these groups lived on agricultural settlements and similarly dependent upon the mainstream economy as their colonial counterparts. .

1.29 Interdisciplinary, Qualitative Case-study research methodology

This research assesses the vulnerability/resilience of the difference geographies and historical periods of the case studies through accurate predictors of increased risk or resiliency for a human zoonotic epidemic to occur. This research, which examined the socio-economic systems and institutions that promoted human activity that increased vulnerability to a human zoonotic epidemic during the mid-14th Black Death from the medieval past to the increase of zoonotic epidemics since German and British colonialism to modern Plague outbreaks in highland Tanzania. This research helps form the foundation to understand those systems and institutions that helped foster resiliency of some marginalised peoples.

There has been an influx of investigations on human zoonotic disease outbreaks, but it has been the comprehensive case study investigations that have proved to be the most dependable (Eisen and Eisen 2007: 1816). Mathematic modelling has been seen as reductionist and lacking in ecological and biological realities

(Hassell *et al.* 2017: 64; Silvia 1997:8) since they overly focus on a few variables (where in reality there are many, some of which are likely unknown), and ecological and biological systems are in constant change, which cannot be adequately accounted for. Instead, the case study approach based upon interdisciplinary, qualitative evidence attempts to comprehensively understand the context for a zoonotic epidemic by identifying the degree of vulnerability or resilience seen at the site being accessed. The emphasis with the case studies of the plague are on the development of the context where a zoonotic epidemic would likely take place or of one that would significantly deter/diminish such an epidemic from taking place.

Zoonotic epidemics may indeed be an indicator of unsustainable socio-economic systems and institutions as well as humanity's increasing separation from the natural world and the ecological systems that we all ultimately depend upon for our lives. However, even if we just concentrate on the relevance of human zoonotic epidemics in their own right, there is a quite compelling case to be made for this to be a topic of more interdisciplinary research. The majority of emerging infectious disease are zoonotic (Jones *et al.* 2008: 990-993) and as Hassell *et al.* (2017:55) state, "it is the anthropogenic influence on ecological systems that dictates the level of risk that operates at the interface between humans and animals in zoonotic disease emergence." Therefore, there is concern within the field of infectious disease ecology regarding what will be the consequence of the continued expansion of human dominated landscapes on the spatial and temporal distribution of wildlife and their interactions with parasites and pathogens (Becker *et al.* 2015: 493).

Parasitic life is dependent upon humans more than any other animal species (Cleaveland *et al.* 2001:991-999) and it seems the reason for this may in large part be due to our way of life, especially the construction of settlements and domestic animal life (Begon 2013; Hassell *et al.* 2017:55; Jones *et al.* 2008:990-993; LaDiso 2017; McMichael 2004: 1049-1058; Morand 2018; Taylor *et al.* 2001: 983-998).. The spread of domestic animals is associated with the spreading of zoonotic disease, as agrarian societies brought the rise of large-scale networks (Armstrong *et al.* 2005:755-765; Barrett & Armstrong 2013;

Karesh *et al.* 2012: 1936-1945; Keim & Wagner 2009:813; Morand 2018) and the expansion of cultivation and animal husbandry.

This work advances a qualitative evidence-based model focusing on geographic areas that have had a large human Plague outbreak or an epidemic that took place that affected area populations differently. The information obtained includes:

- previous qualitative research carried out on the period where the zoonotic outbreak/epidemic took place
- evidence obtained in the site must include an ecological survey/palaeoecological data, archaeological, written and/or ethnographic evidence of socio-economic changes leading up to the outbreak/epidemic

While part of the model is focused on ecological factors, the other on the impact of socio-economic systems and institutions influencing human activity, leading to the ecological change, goes to the root of the problem. This research examines the human activity perpetuates human vulnerability to food insecurity and disease. However, the other aspect of this research is that some human activity leading to ecological and organisational changes increases resiliency of the people in the decreased infection and fatality rates to zoonoses. The table below highlights the areas of inquiry, methods of data collection, as well as the methods of analysis that is used in these case studies.

Table 1.5-Inquiries into risk of Human Zoonotic Epidemics

<u>Area of Inquiry</u>	Data Collection Methods-Relevant Fields	Analysis-Fields & Key Theorists
Based upon the vulnerability factors for a human zoonotic epidemic, ⁸ is there evidence of heightened risk at the site?	Ecological survey, palaeoecological, written, anthropological (eg. ethnographic), archaeological (e.g. architectural structural evidence of diminished human-animal barrier; human and animal skeletal evidence)	Infectious Disease Ecology; McMichael, Begon, Laudisoit
Is there evidence of food insecurity & malnutrition/co-infections? ⁹	Ecological survey or palaeoecological evidence, written, ethnographic evidence, archaeological (e.g. skeletal evidence)	Ecology, Infectious Disease Ecology, Biological Anthropology, Medical Evidence; Begon, DeWitte
Is there evidence of deforestation, vegetative clearance, &/or erosion? ¹⁰	Geographical and Geological evidence (e.g. sediment rate at nearby rivers/lakes, age of forested area based on species presence & growth) archaeological	Geology, Geography; Dotterweich, Montgomery
Has there been an increasing emphasis on language built for trade over ecological observation? ¹¹	Ethnographic and written evidence	Social Linguistics; Whorf

Is there evidence of trade/economic change leading to educational/enculturation change in society? ¹²	Written, Ethnographic evidence, Archaeological (i.e. architectural and other evidence of socio-economic change)	Intellectual History, Educational Psychology, Sociology/Anthropology; Bloom, Kaye, Mann
Is there evidence of growth in Social organisational size & complexity, which diminished the society's problem solving efficiency? ¹³	Written, archaeological (e.g. architectural), and/or anthropological (e.g. ethnographic),	Sociology/anthropology, history; archaeology; Tainter, Mann, Jones, Parkes
Is there evidence of societal instigation of an ecological crisis through unsustainable socio-economic systems and institutions? ¹⁴	Ecological survey, palaeoecological, written, and archaeological (e.g. skeletal evidence of animals, evidence of adaption through different trade, population movement, architectural changes	Ecology, Biology, Anthropology, Archaeology; Van De Leeuw

This proposal focuses on testing these characteristics of risk in different geographic areas where the human zoonotic epidemics or large outbreaks have taken place in order to advance a modelling tool to help address global health and systematic socio-economic unsustainability. This qualitative model based on the above points of inquiry will be reviewed in the last chapter. It is hoped that this research may be built upon to establish an assessment protocol for a qualitative model to both test better understand what took place during zoonotic epidemics in the past as well as assessing the degree of vulnerability/resilience to a zoonotic disease epidemic of different geographic areas in the present.

Chapter 2-Methodology

2.1 Why an Interdisciplinary Study?

Interdisciplinary studies that truly bring the natural and social sciences together in order to address misperceptions of the past are indeed rare. However this is essential to do as our view of the world is based upon our perceptions of the past. Therefore, when the decisions and actions we take today are based upon false beliefs, then we cannot expect anything but poor, unsustainable results. This is especially notable in our era of ecological crisis, which is largely acknowledged to be caused by human activity, as well as world of decreasing security that has led to increased violence in various forms.

This study focuses on what caused vulnerability and resilience to the plague during Black Death through investigations into different aspects of the pandemic (an investigation into what transpired and the context that led to the mid-14th century pandemic based upon the *Y.pestis* genome map, modern examples of the development of vulnerability and resilience to zoonotic disease epidemic (as the plague), vulnerability and resilience in the socio-economic context that Black Death took place within in the context of Ireland and the larger context of Europe and the Mamluk Empire) through assessing different relevant expertise whether it was through my own training, gaining expert assessments from different fields in the natural and social sciences. The key for this integration was keeping the emphasis upon the cause-effect of changes in human activity and the natural environments and vulnerability and resilience to the plague. It is important to remember that natural phenomenon is the reality to be observed, which must not be preceded by particular principles of a hypothesis or theory of any particular field, as every field's perception cannot be correct all the time. Part of the advantage of interdisciplinary/transdisciplinary studies is the ability to find errors that may not be caught in field-specific studies, but this is also the most challenging aspect of these studies, as all the researchers must deal with potential errors in their discipline that had become commonly accepted as valid. This is likely a key reason why cooperation between the social and natural

sciences has been quite low, as the differences between some of these disciplines, as history and biology can lead to a high degree of disagreement. It is only through keeping everyone focused upon the natural phenomenon being studied itself that this barrier can be overcome.

The great divide of the biological evidence and the narrative of the Black Death that we were all taught in school is striking. The standard narrative is that the Black Death appeared suddenly and was extremely contagious and indiscriminately killed like no other infectious disease in the history of humanity. This disease was assumed to have been very distinct from the plague that we know today. The epicentres of the plague were the ports and cities and the black rat spread the epidemic with its fleas as the vector of the disease. Ships have continued to be viewed as the vehicle that helped spread this disease so rapidly around the Mamluk Empire and Europe. However, the biological evidence refutes or at least questions all of what we were taught.

Where to go from here to address this divide? Weingart (2010) argues in *A Short History of Knowledge Formations* for a uniting of knowledge instead of the field-specific research approach,

It is the custom of scholars when addressing behaviour and culture to speak variously of anthropological explanations, psychological explanations, biological explanations, and other explanations appropriate to the perspectives of individual disciplines. I have argued that there is intrinsically only one class of explanation. It transverses the scales of space, time, and complexity to unit the separate facts of disciplines by consilience, the perception of a seamless web of cause and effect. (Weingart, 2010:297)

The focus on cause and effect in studying phenomenon instead of having field-specific theories guiding an investigation does seem key for integrating different fields and thought processes together. Certainly, it would not be possible to base

an interdisciplinary or transdisciplinary study on the theories of a particular discipline. Burggren *et al.* observes a common perception among scientists that biology is especially well positioned to integrate with other fields of study. He explains that this development may be intrinsic to the human experience,

...curiosity about our biological surroundings and its role in it pre-dates the written word, as evident in ancient cave drawings at Lascaux (c.16,000BP) depicting the living world around the artist. Likely as ancient is the interplay between biology (as our ancestors perceived it) and other human endeavors, including religion, art, and the emergence of technology. From these origins has arisen the discipline of biological sciences—a discipline that is fundamentally shaped by its interdisciplinary activities. (Burggren *et al.*, 2012:119)

Though we may have gotten away from it, nature is inherently interdisciplinary/transdisciplinary. The creation of disciplines and the adherence to field-specific theories as the bubble that observation of a natural phenomenon takes place limits the degree of the observation. This means that the field-specific theories are what gives the study legitimacy over the results of the study of a cause-effect phenomena. Repetition of these cause-effect observations of natural phenomena will only be accepted if the theories used in a particular discipline are the tools used in the study. However, what if these tools are insufficient to observe the cause-effect of the natural phenomenon, does that mean a cause-effect reaction did not happen? Of course not, therefore, we must do what we can bring sufficient tools on board in our studies to diminish our blind spots to observe the cause-effect of different phenomena that we investigate.

We also must understand that the context that our academic disciplines were born from was not one that had a tradition that fostered heightened awareness of our natural surroundings and discovery, but rather a knowledge economy that controlled the dissemination of accepted, esteemed information. Medieval European universities were centres of communication of approved knowledge and doctrine of the Church (Turner, 2017:9-12). The continuation of this ecclesiastic institution in the secular realm still maintained many of the same procedures. After the Protestant Reformation, protestant universities

increasingly offered non-legal and non-theological classes that followed the same system where students would take down the dictation of the teacher (Turner, 2017:22). It was actually outside the universities that the evolution of disciplines occurred. For instance, patrons outside the university supported Galileo and other “Renaissance Men” were non-academics that organised groups to communicate with different professionals and scholars (Turner, 2017:20). These intellectual hotbeds were both controversial and influential and others began to appear, as the Royal Society in Britain and The Paris Academy of Sciences, which set rules for enquiry that would eventually be incorporated into universities (Turner, 2017:21-22). During the nineteenth and early twentieth century the modern version of the academic disciplines emerged and solidified (Turner, 2017:23). However, interdisciplinary research began to gain attention as the Great Depression approached. During the roaring 20s, the Social Science Research Council (SSRC) was formed to foster interdisciplinary research in the social sciences. Charles Merriam, a political science professor at the University of Chicago, was one of the main advocates for its formation stated,

The problem of social behaviour is essentially one problem, and while the angles of approach may and should be different, the scientific result will be imperfect unless these points of view are at times brought together in some effective way, so that the full benefit of the multiple analysis may be realized (Calhoun and Rhoten, 2012:106).

After the Great Depression the resolve in the SSRC intensified, as exemplified in September 1930, “when the SSRC was already re-examining and restating its existing policy when it declared,

The Social Science Research Council is concerned with the promotion of research over the entire field of the social sciences. The Council’s thinking is thus far has been largely in terms of social problems which cannot be adequately analysed through the contributions of any single discipline. It is probable that the Council’s interest will continue to run strongly in the direction of these interdiscipline inquiries. (Calhoun and Rhoten, 2012:106)

This quest for interdisciplinarity reached another level in the universities in the 1950s, which was helped by Rockefeller philanthropy (Turner, 2017:24). However, as Turner notes, retired economist Milton Friedman complained to a group of young economists “about the direction the discipline had taken, which he thought involved a substitution of mathematical prowess for intellectual substance. One of the younger economists responded by observing that was what the market—by which he meant the internal market in economics as a discipline—demanded (cf. Frodeman, 2014. Sustainable knowledge: A theory of interdisciplinarity.). Because conformity is rewarded, the market produces a level of coercion that inculcates standards and attitudes that are very resistant to change” (Turner, 2017:24). The societal consequences of the shortcomings of the discipline of economics became highlighted as the field failed to predict the financial collapse of 2008. Economist Hodgson asked, “Does this crisis create favourable conditions for the reform and revitalisation of economics itself – from a subject dominated by mathematical techniques to a discipline more oriented to understanding real-world institutions and actors?” (Hodgson, 2009:1219). Hodgson goes on to note that this realisation of field insulated from reality was seen by students well before the crisis to the degree it led to protests,

In June 2000 some economics students in leading academic institutions in Paris circulated a petition calling for the reform of their economics curriculum. They complained of a “disregard for concrete realities” in an approach that “is supposed to explain everything by means of a purely axiomatic process, as if this were THE economic truth” and called for “a pluralism of approaches, adapted to the complexity of the objects and to the uncertainty surrounding most of the big questions in economics.” This protest attracted significant global attention and was followed by similar initiatives at the University of Cambridge and elsewhere (See <http://www.paecon.net/HistoryPAE.htm>). (Hodgson, 2009:1219)

There is no reason to think that economics is intrinsically different than other disciplines, it is just the field of study’s short-comings became immediately obvious to the whole world. Thus, the discipline needed to speak to these short-comings. However, similar remarks could be said about the historical narrative of Black Death, as more biological DNA evidence is found that refutes much if not most of the narrative that has been taught to the public for generations. This is

the only narrative about an epidemic that most people know and it appears largely incorrect. What is the consequence for this? People's actions as well as the actions of their politicians are based upon what they believe to be true. However, acting upon false information may result in increasing an individual, a society's, and increasingly our world's risk instead of security.

The observation and study of nature is the foundation of all the natural sciences, however streamlining data to fit into mathematical models has also taken to the forefront in legitimising findings. However, some concerns with this practice has also been aired, particularly in the life sciences, as May (2004) stated,

In the physical sciences, mathematical theory and experimental investigation have always marched together. Mathematics has been less intrusive in the life sciences, possibly because they have until recently been largely descriptive, lacking the invariance principles and fundamental natural constants of physics. Increasingly in recent decades, however, mathematics has become pervasive in biology, taking many different forms: statistics in experimental design; pattern seeking in bioinformatics; models in evolution, ecology, and epidemiology; and much else (May, 2004:790).

May goes on to explain the tendency to going into elaborate detail in regards to some factors while other, equally important factors are unknown or uncertain. He goes on to quote Einstein view of models, when he stated, "models should be as simple as possible, but not more so" (May, 2004:793). The point being that models are not equipped to accurately incorporate fluctuating or unknown variables, as well as control for known variables that are not being tested for, while running the risk of over-emphasising the known variables that are accounted for. Thus, while models may be useful in showing a trend or tendency, they should not be expected to give accurate results, significant error must be seen as a given. Thus, the mathematical model alone should not be seen as decisive evidence.

Interdisciplinary/transdisciplinary work is able to eliminate many "blind spots" in the assessments of the cause-effect phenomenon being investigated. However, not all interdisciplinary/transdisciplinary work eliminates "blind spots" to the same degree. Although some studies may be called

interdisciplinary, they often entail related disciplines, which does not result in a dramatic decrease of the “blind spot(s).” However, these studies tend to have less disagreement and are easier to reach a consensus with the co-authors. A rule of thumb may be the greater risk of disagreement, the more dramatic potential for decreasing the “blind spot.” The benefit for this integration of a broad range of disciplines is often required to solve complex problems as Boradkar (2017) stated, “The collaborative strategy that transdisciplinarity brings to problem solving can help deal with the complexity of design problems. However, the highest possible level of integration among disciplines is necessary for this strategy to be truly effective. Only thus can society’s wicked problems be tamed” (Boradkar, 2017:466).

Though this collaboration of the natural and social sciences of studies of the past are very rare, it is these studies that are designed to bring about a fuller picture of the phenomenon being analysed to come up with more sustainable findings that can last the test of time and contribute to taming wicked problems in the present and help avoid such problems in the future.

Interdisciplinary/transdisciplinary research that focuses upon the past has some complications that investigations of the present do not have, or have to a diminished degree. The first point is that most studies of the past do not have access to stake holders who are directly affected by the phenomenon being studied. Stakeholders are able to provide unique insights as they are in the midst of a situation and have a great incentive to understand and solve the problem. They may be able to give information regarding the progression of the problem being studies and how and why this problem developed, and where potential greater vulnerability lies. Stakeholders may also provide ideas on ways that the problem be diminished or eliminated, and/or offer strategies to diminish or potentially eliminate future risk. All of this is very useful information for the contemporary researcher, not only for the insight, but also in involving the stakeholders in being a large part of the solution.

Investigations of the past will typically lack the access of information from studies of different disciplines and a variety of studies, as the variables being studies are all present in a contemporary study, but in an investigation of the past this will not be the case. However, past studies have the advantage of reviewing previous research and critiques of that research to a much greater degree with that contemporary studies of a phenomenon have access to. Nevertheless, research of the past tends to have greater holes in the investigation that increase the potential for error. Thus, partaking in interdisciplinary studies of the past can potentially alleviate many of these 'blind spots'. I have developed seven sub-spheres in analysing past societies that help eliminate large 'blind spots'. These four spheres of comprehensive interdisciplinary research of the past are:

- 1) & 2) Ecological & Biological change through Human Activity
- 3) & 4) Social-Organisational and Economic Systems
- 5) & 6) Collective perceived authority/spirituality & collective perception of past
- 7) Language- Education/Enculturation

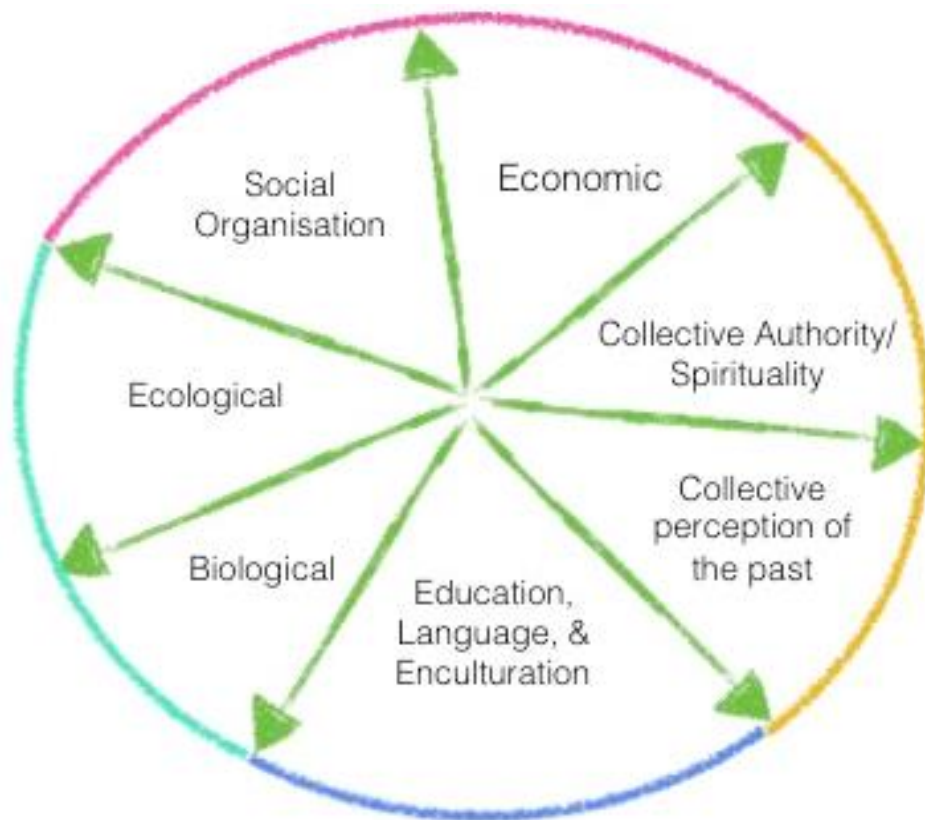


Fig.2.1. The Seven Spheres of Comprehensive Interdisciplinary Research

The first and second sub-spheres, Ecological & Biological Change through Human Activity traces change of vegetation and animals in the region being investigated.

The biological change is assessing the transformation taking place within biological life within the ecosystem being studied. The assessment of ecological change refers to the context that the biological change takes place within and researching how the environment may have fostered these biological changes.

The assessment of ecological and biological data is unique in its direct evidence of how a people altered their environment. The means to do this type of assessment of the more ancient past has grown tremendously with the greater capacities of palaeoecological research, which can give a foundation for the type of ecologies people of the past depended upon, and therefore, insight into a society's basic economic system. Through the degree of information will vary from site to site, this ecological data is invaluable in gaining insight to a society's relationship they had with their environment as well as the economic system used in the society. This information can be used to assess the state of

sustainability and health, the degree of functioning of life and ecological systems, potential changes in micro-, local, and regional climates (due to vegetation changes in biosphere), as well as an analysis of vulnerability and resilience within these ecological systems in regards to human life.

The third and fourth major spheres are Social Organisational, & Economic Systems, which focuses on the institutions and systematic human activities that they supported to sustain a society through addressing various needs or societal priorities. Ecological data from the previous sphere along with historical and archaeological information would form the foundation of knowledge of what institutions were in place and how these societal systems functioned. Tainter's (1988:118) four concepts that lead to understanding social organizational collapse will help guide this investigation in terms of understanding the changing organizational capacities to deal with a society's problems through a sustainable use of resources. Tainter's four concepts are:

1. Human societies are problem-solving organizations,
2. Socio-political systems require energy for their maintenance,
3. Increased complexity carries with it increased costs per capita,
4. Investment in sociopolitical complexity as a problem-solving response often reaches a point of declining returns. (Tainter, 1988)

The questions here being whose problems and what problems were these organisations set up to address and can human health and zoonotic disease prevention be efficiently and effectively dealt with by these organisations. Additionally, as institutions increasingly grow into large, complex organisations, they are likely to decrease in efficiency. Sustainability, vulnerability, and resiliency in these systems should be a focus as an increase in vulnerability will either provoke a society to adapt and make needed change or eventually be forced to face a crisis. Van der Leeuw's (2009) 'What drives socio-environmental systems regularly towards a crisis?' will be used in conjunction with Tainter (1988:118) to address these issues of the degree of connection a society has with the ecologies that they depend upon to continue. Van der Leeuw (2009:47) notes the three focal points in his evaluation of the question:

1) The Potential of the System (in sustainably expanding ecosystem services needed by a population)

2) (The) connectivity between (organizational) levels and the internal control variables and processes.

This refers to the internal socio-organisational sensitivity to observe and adapt to ecological changes, especially to the changes in ecological system services a population depends upon.

3) The adaptive capacity of the system

This refers to a whole society's level of adaptive capacity to observe and make the necessary adjustments, efficiently.

The focus here will be on how well a society is creating greater resiliency and is sustainable in its instituting actions that affect the natural environment, and if these actions are actually increasing vulnerability for environmental crisis as well as the risk factors for a zoonotic epidemic.

Sustainability, vulnerability, and resiliency in these systems should be a focus as an increase in vulnerability will either provoke a society to adapt and make needed change or eventually be forced to face a crisis. Thus, characteristics that should be assessed about an economic system are tied to the natural environments that it ultimately depends upon. What factors does the economy mainly focus upon and adjust to? If the sustainable use of resources is not a top priority, then the economy being studied is not a sustainable one. What is considered the ideal range of outcomes for individuals functioning within the economy being studied? Understanding these individual goals is largely bound to the education/enculturation of the society that prepares individuals to thrive within their economy. Social Organisation (as well as Language, Education/Enculturation is entwined with the society's ability to observe and efficiently react to the society's economic priorities as well as other problems the society is faced with. If the social organisation is hierarchical in construction, then authority plays a crucial role in the society's collective perception of the past as well as what should be instituted in the present. However, if the organisation is more consensus based then individuals in the society are more

participatory and likely to be arranged in smaller groups, which are responsible for their own locality. These groups would be better equipped to observe changes that would concern the group and they would be able to efficiently adapt to those changes than a larger hierarchical organisational structure. Thus, smaller organisations with less hierarchy tend to be more resilient, whereas larger hierarchical organisations have greater capacities for power and influence over many people.

The fifth and sixth sphere is the Collective perceived authority/spirituality and Collective perception of the Past (which authority is legitimised form) assesses the ecological data, the historical and archaeological information, along with evidence from the fourth sphere (Language & Education/Enculturation) through linguistic evidence as well as historical and archaeological evidence of the institutionalising certain systems of education and enculturation in the society.

These spheres analyse what source(s) of information is seen as the most esteemed/sacred, what authority(ies) analyse this information for society, where does his/her/their authority stems from, as well as comprehending the societal basis for understanding of the past, who is considered an authority(ies) in interpreting the past, where does his/her/their authority come from, and what is the relationship between the authority(ies) of the past with those that authority in the society (or if this authority(ies) one in the same). The societal organisation of this authority is also an important aspect to analyse, in that is it part of a hierarchical structure, and if so analyse how the structure came into being, or is it based upon consensus. This sphere highlights what is the most esteemed, or sacred information that a society pays attention to, which serves as the building blocks that the societal institutions and authority is founded upon.

The last sphere, Language, Education/Enculturation, is the realm continues from the previous sphere in being founded on the perception of the past and the consequential belief in the society's esteemed/sacred and authoritative knowledge, along with the legitimacy in the position(s) of authority that are followed. The language of the society organises the knowledge and information according to these societal beliefs and in a way that makes it most easily

adaptable to the socio-economic demands they need the information and knowledge for. The system of education and enculturation follow suit in gathering and organising information and knowledge in a way that best serves the purposes set out by the societal institutions in order to meet the societal and economic demands of the society.

This sphere will require research in linguistics, as well as knowledge of educational psychology, sociology and anthropology in the analysis of ecological, historical, and archaeological evidence in order to gain understanding of how learning takes place and how this organisation of information and knowledge supports the societal institutions and the society as a whole. This research would further entail investigating what type of socio-economic system does this information support and how this takes place, how the information is organised and how knowledge is formed, as well as where the information/knowledge that the society studies is gathered from, what determines if information/knowledge is coming from a legitimate source, and what are the characteristics of this information/knowledge.

The investigation of a phenomenon in a past society may lead to a greater emphasis upon a sphere(s) over others as well as a greater focus in certain aspects of a sphere over others. For instance, in this investigation on Black Death the focus was on vulnerability factors that promote the risk of a zoonotic epidemic, which concentrated upon ecological changes (which subsequently caused niche changes within ecosystems that created opportunities for some species over others, as well as unsustainable characteristics that effected the biological health of some species within the ecosystems affected by this change). Thus, the first two spheres, Ecological & Biological Change through Human Activity was concentrated upon more than some other investigations of the past might have. However, the other three spheres also played important roles in the development of these vulnerabilities (as well as the resilience) of the zoonotic plague epidemic. Resiliency and sustainability is important to study not only to learn about the society that is being investigated, but also what we can learn and take that we may have been lost through the generations. Vulnerability is also

very important to research as we can evaluate how it has developed and to what degree it evolved in our own socio-economic institutions.

Black death certainly constitutes a wicked problem and unlike problems in the present, where most interdisciplinary/transdisciplinary methodologies are applied, there is no one presently alive that can provide direct evidence of Black Death and much information has been lost on the pandemic. Clearly we cannot test for a particular variable and expect to find a conclusive result. However, we can take this comprehensive interdisciplinary/trans-disciplinary approach to foster questioning of each different line of enquiry from different fields or schools of thought. Mono-disciplinary approaches only need to survive questions based from accepted theorists within a particular field, which isolates and “protects” the line of inquiry from being refuted, even if solid proof from another field would prove it false. Using a broad range of disciplines addresses the main weakness of the scientific method, namely that we cannot identify and control the variables in a natural setting. Natural settings are continually changing, mutating, and developing in ways we do not fully realise let alone can control. Therefore, research of complicated problems in a natural environment benefits from continual questioning from multiple perspectives is much less likely to proceed with gross errors, and accordingly is much better suited to address complex, wicked problems.

The foundation for our perceptions of the present and future are rooted in our perceptions in the past. It is hoped that more comprehensive interdisciplinary studies of the past, as this seven sphere approach fosters, can help eliminate misperceptions of the past so that we can build more resilient and sustainable societies based on merit. The increased presence of zoonotic disease in our modern world and the connection to our increasing frequency and intensity of crisis in the natural world is very concerning, but under our control.

This work advances a qualitative evidence-based model focusing on geographic areas that have had a large human Plague outbreak or an epidemic that took place that affected area populations differently. The information obtained includes:

- previous qualitative research carried out on the period where the zoonotic outbreak/epidemic took place

- evidence obtained in the site must include an ecological survey/palaeoecological data, archaeological, written and/or ethnographic evidence of socio-economic changes leading up to the outbreak/epidemic

While part of the model is focused on ecological factors, the other on the impact of socio-economic systems and institutions influencing human activity, leading to the ecological change, goes to the root of the problem. This research examines the human activity perpetuates human vulnerability to food insecurity and disease. However, the other aspect of this research is that some human activity leading to ecological and organisational changes increases resiliency of the people in the decreased infection and fatality rates to zoonoses. (See Table 1 in previous chapter for areas of inquiry, methods of data collection, as well as the methods of analysis that is used in these case studies).

2.2 Defining what constitutes human vulnerability for a zoonotic epidemic

Adger has stated that “Vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt” (Adger 2006). This goes to the heart of the research of infectious disease ecology. Studies over the last couple of decades reveal that vulnerability-factors for human epidemics of zoonotic infectious disease (transmitted from an animal reservoir) include high population densities, human induced changes in the biological make-up of ecological systems and the distinct human interaction within these new ecosystems, intensive herding and farming practices, malnutrition, and prior ill health (See studies of malnutrition and disease in skeletal evidence, i.e. Armelagos, Brown, and Turner 2005; DeWitte and Hughes-Morey. 2008; DeWitte and Hughes-Morey. 2012; DeWitte and Slavin, 2013; Logan 2016; Murphy *et al.* 2013; Power 1985-1986; Power 1993; Power 1994). These ecological factors that help create the context for an epidemic to take place. McMichael, Begon, and Laudisoit have identified ecological characteristics that increase vulnerability for human epidemics of zoonotic (animal transmitted) infectious disease that are shown

below:

McMichael's Six Vulnerability Factors for a Human Epidemic of a Zoonotic Disease:

- a) Altered habitat, with proliferation of reservoir or vector populations:*
(i.e. increasingly wet areas, dramatically increasing rodent populations' ideal habitat)
- b) Biodiversity change and habitat fragmentation* (e.g. deforestation)
- c) Ecosystem changes, loss of predators and host species imbalance* (e.g. Forest fragmentation)
- d) Intensified farming and animal husbandry* (e.g. closer interaction with animals lead to new strains of virus or bacteria being created, making it better adapted to avoid immune defences)
- e) Niche invasion* (e.g. the emergence of some infectious disease results from a pathogen invading a new or recently vacated niche.")
- f) Human-induced climate change* (e.g. land cover change has been tied to regional climate change.) (McMichael 2004: 1054-57).

Begon's Vulnerability Factors for a Human Epidemic of a Zoonotic Disease:

- 1) The increased presence of emerging infectious disease (EID) in area wildlife
- 2) The increased interaction of area wildlife with humans
- 3) The increase vulnerability of human populations to infectious disease
- 4) The increase potential for human to human transmission through greater population densities and increased movement both within and among different populations (Begon 2013, personal communication.

Laudisoit's factors of risk for a zoonotic epidemic (adapted for assessment of Medieval past)

- A) High population fertility and the population growth next to hotspots is higher than in non-forest areas (urban bloom is mainly due to immigration – rural exodus)

- B) Encroachment in pristine forests
- C) Bushmeat consumption
- D) Land-use changes and conversion of land in agricultural surface
- E) Disturbance of interactions between species causing species range shifts and increased contacts with domestic animals and humans (one health)
- F) Trade of forest products and bushmeat and the illegal or uncontrolled nature of the trade
- G) Increase in edges of the forest as these regions are broken down into smaller fragments, leading to greater human (anthropic) disturbed surface and a greater interface between humans and fauna and the zoonotic pathogens they carry (Laudisoit, 2017, personal communication) (See also Jones, K.E. *et al.* 21/02/2008. Global Trends in Emerging Infectious Diseases. *Nature*. 451:990-993; Wolfe, N.D. *et al.* 17/05/2007. Origins of Major Human Infectious Diseases. 447:279-283; Wolfe, N.D. *et al.* Bushmeat Hunting, Deforestation, and Prediction of Zoonotic Disease. *Perspective*. 11.12:1822-1827)

Notice that these factors are very much tied to human activity and can be tied to vulnerabilities of an expanding cash-crop economy that are fostered by a socio-economic system based upon large-scale trade. Ecological factors; deforestation and cultivating foreign and domestic species of crops and animals for the international marketplace (which increases the reservoir and vector population esp. certain rodents), means people would have increased interaction with area wildlife. Also the economy would have increased the dominance of introduced species while diminishing the biological complexity and intensity. Additionally, as Laudisoit indicates, the fragmentation of the forest creates greater contact between humans and wild animals as well as the zoonotic pathogens they carry. The risk of human infection to zoonotic pathogens is heightened by the hunting of wild animals for meat (and possibly furs and other animal-products). We can break down the risk factors for a human zoonotic infectious disease epidemic into two groups:

- A) Those that increase the risk of a pathogen reservoir of the commensal animal populations that depend upon human populations; and
- B) The breakdown of the barrier between commensal animal populations

and humans, as well as a systematic problem that compromises biological defense systems of human populations.

McMichael's vulnerability factors largely focus on the increased risk of a pathogen reservoir of commensal animal populations that are "domesticated" in that they depend upon human activity and socio-economic organization to create a beneficial environment for the animals to thrive. For instance, rodents that feed off of grain storage in agricultural areas would be an example where quick breeding rodent species can adapt to the food source, which leads to a population boom. McMichael's factors concentrate on the circumstances that increase the risk for pathogen reservoirs to develop in these areas of human activity that have altered ecological habitats in a way that made them more hospitable for these pathogen reservoirs to form in commensal animal populations. Laudisoit also illustrates two factors that heighten this vulnerability for pathogen reservoirs, D) *Land use changes and conversion of land in agricultural surface*, and E) *Disturbance of interactions between species causing species range shifts and increased contacts with domestic animals*. Begon's first factor, *The increased presence of emerging infectious disease (EID) in area wildlife*, also would effect commensal animal populations. If a society has these risk factors for a zoonotic epidemic, but do not include most of the factors that break down the animal-human barriers or societal issues that comprise people's immune systems, then the zoonotic epidemic may largely stay within animal populations and rarely effect humans.

The factors that illustrate the breakdown of the animal-human barrier are seen in Begon's second factor, *The increased interaction of area wildlife with humans*, as well as Laudisoit's factors, B) *Encroachment in pristine forests*, E) *Disturbance of interactions between species causing species range shifts and increased contacts with domestic animals and humans (one health)*, and F) *Trade of forest products and bushmeat and the illegal or uncontrolled nature of the trade*, and G) *Increase in edges of forest as these regions are broken down into smaller fragments, leading to greater human (anthropic) disturbed surface and a greater interface between humans and fauna and the zoonotic pathogens they carry*, while McMichael's factor, d) *Intensified farming and animal husbandry (which leads to closer*

interaction with animals, leading to new strains of virus or bacteria being created, making it better adapted to avoid immune defenses). While these factors highlight infected animals and humans living in the same space, leading to contact and the spreading of a pathogen, diminished human defenses to disease also play an important role. These factors include that which fosters human to human transmission, as Laudisoit's A) *High population fertility and the population growth next to hotspots is higher than in non-forest areas*, and Begon's fourth factor, *The increased potential for human to human transmission through greater population densities and increased movement both within and among different populations*. While these factors will lead to exposure to the zoonosis, it is a breakdown in the immune system itself that ultimately leaves people vulnerable, as Begon's third factor points out, *The increased vulnerability of human populations to infectious disease*.

The different degrees of commensal animal and human vulnerability to a zoonotic disease epidemic helps assess why some areas that may have an epidemic within the commensal animal population have few cases within human populations. However in both cases, human activity is key for augmenting vulnerability. These human-induced ecological changes help form a potential new niche that a pathogen and opportunistic host species could take advantage of. Dramatic ecological changes, such as deforesting an area for large-scale agriculture (Harkins and Stone ,2015:137-14) and foreign plant and animal niche invasion (Mitchell *et al.*, 2006:734; Mack *et al.*, 2000:695-700) would have helped provide a new void that could be quickly filled, by *Y.pestis* and *Y.pseudotuberculosis* (ancestral bacterium of *Y.pestis*) (Shapiro *et al.*, 2016; Wilcox & Gubler, 2005:265).

As indicated in the previous chapter, this interdisciplinary work will also refer to other theorists as Mann's degree of centralization for a society, Jones' administrative accounting as in indicator for a centralized and relatively rigid society, Angourakis *et al.*'s 'Musical Chairs' on the competition between agriculturalists and herders, Kaye's theory on the influence of the coin-based economy on intellectual history, and Bloom's Taxonomy of Levels of Cognition. This work will use these and previously mentioned theorists from different

disciplines in order to do four interdisciplinary, comprehensive, qualitative case study assessments. These case studies will be assessed using inquiries from the table above. These assessments will then be compared and conclusions will be drawn with the hope of developing a tool to assess the degree of a site's vulnerability or resiliency to a human zoonotic epidemic.

Chapter 3-The Evolution of the Mongol Empire and the transformation of the landscape, ecology, and socio-economic systems

Overview

The genome map of *Yersinia pestis* indicates that the Tibetan Plateau and adjacent regions was probably the origin of the strains of the pathogen responsible for the plague during Black Death in the mid-14th century (Bos *et al.* 2011:506-511; Cui *et al.* 2013: 577-582; Drancourt and Raoult. 2016:1; Haensch *et al.* 2010:5; Krause 2016). Trade from the Tibetan region to Europe and the eastern Mediterranean was minuscule up to the mid-fourteenth century. Thus, it is unlikely that the “Silk Road” would have been substantial enough to spread the mid-fourteenth century pandemic across the region (Atwood *Per.Comm*). However, the western expansion not of people but huge herds of the Mongol Empire was unprecedented in scale. This enormous movement of horses and livestock demanded huge resources to support. Therefore, continued deforestation and clearance, agricultural cultivation, overgrazing and other environmental changes led to increasingly hospitable environments being created for the establishment of *Y.pestis* reservoirs in western Asia, eastern Mediterranean, and Europe. Examples of these potential reservoir regions include the Golden Horde and Il-Khanid Iran, where the Mongols had a continued presence, as well as areas where they had shorter presence and established trade with the Mamluk Empire and Europe.

The ecological and socio-economic changes wrought by the Mongol advancement were a consequence of supporting huge herds of horses and livestock and the intensification of agriculture managed by a centralized government with the military as its top priority. The Mongols and those that had united them often did not settle in one place for very long. However, this was not the case for most Europeans as well as those in the Mamluk Empire of the southeast of the Mediterranean. Vulnerability for a plague epidemic in human populations was especially high in Europe and the Mamluk Empire, due to the history of overexploitation of resources around settlement areas that led to an increase of risk factors for a human zoonotic (animal transmitted) infectious disease epidemic.

This paper investigates the feasibility that *Y.pestis* reservoirs were being formed during the thirteenth century in the Golden Horde, Europe, and/or the eastern Mediterranean decades before Black Death, and if so how did this occur. This research follows the data from recent *Y.pestis* genome investigations and builds the social, economic, and ecological context in which the spread of the pathogen occurred. Most research has focused on the re-introduction of the pathogen to Europe and the eastern Mediterranean during the mid-14th century. However, the recurrence of the plague in the same geographic areas has been a characteristic of zoonotic disease (animal transmitted disease to animal/human), which is well documented from the Middle Ages to modern outbreaks (Borsch, 2014:125-156; Bos *et al.*, 2016:1-11; Carmichael, 2014:157-192; Eisen, 2008:1-14; Neeinchkx *et al.*, 2010:102; Seifert *et al.*, 2016:1-8; Shrewsbury 1970; Varlik, 2014:193-228.).

A list of vulnerability factors of a zoonotic epidemic in humans (developed by McMichael, Begon, and Laudisoit) helped guide this investigation in following where the greatest risks would lie. This was done by tracking large-scale human activity that affected livestock and human population density, and subsequently micro-, local, and regional climates, as well as burrowing rodent behavior and the risk of establishing a reservoir for *Y.pestis*. These factors will be used to assess the change in risk for a zoonotic epidemic, as well as areas of resilience, from the birth of the Mongol Empire to its expansion and trade associations to Europe and the eastern Mediterranean.

Investigating a zoonotic epidemic is a complex problem, and this is certainly true for the world's most studied zoonotic epidemic, Black Death. Therefore, an interdisciplinary approach is used to eliminate errors that a more linear, field-specific approach would not be equipped to find while the approach helps ignite more sustainable research directions that could not be obtained without this multi-disciplinary methodology. This paper is based on the question posed by genomic research that *Y.pestis* reservoirs may have been in Europe and/or the eastern Mediterranean well before the mid-14th century. The context that this may have occurred within is developed through research in the fields of Mongol

and Golden Horde history and archaeology, molecular biology, botany, soil science, climatology, geography, and European and Mamluk history and archaeology.

The first section, *The Evolution of the Mongol Empire and the transformation of the landscape, ecology, and socio-economic systems*, centres on the Mongol impact on the habitat that may have been conducive for *Y.pestis*, to be able to migrate from Tibetan Plateau region to Europe and the southeast Mediterranean. This section illustrates how the expansion of Mongol territory had an effect of homogenization of the landscape that developed through the demands for certain ecosystem services that were obtained through large-scale herding, agricultural cultivation, and extensive hunting of wildlife. This took place as the Mongol economic system and centralised organisation took hold, expanding large-scale expansive herding as well as agriculture and plant and animal introductions to new geographies while delivering commodities from wild and domesticated animals as furs and leathers. Special emphasis will be given to the Tibetan Plateau, which has been known for its large grazing lands. This made Tibet an attractive and ambitious target for the Mongols, which Chinggis Khan did not take lightly (Atwood, 2014: 29).

The next segment, *Mongol Expansion Following Precipitation & Emergent Grasslands & Identifying the Impact their herds had on these Lands*, illustrates the general greater precipitation of the period may have enticed the Mongols to migrate. Contemporary accounts speak of enormous herds and horses for their cavalry of unrivalled size. These animals had to have abundant grasslands to feed upon, quickly leading to areas being overgrazed when the Mongols settled in the same location for too long or the area lacked sufficient grasslands, as Atwood and Bold illustrate.

The third section, *Wetness, increased herding densities, and erosion of grasslands*, shows the impact increased wetness may play in a zoonotic epidemic and how large-scale herding in Mongolia and central Asia has caused over the centuries. This process of overgrazing grasslands particularly effects the deterioration of grasslands and the processes of aridisation of the land, which lead to the creation of dust storms. As the vegetation cover diminishes the soil temperature increases and so does the rate of evapotranspiration, leading to a drying effect on

the soil. Pollen diagrams and other geophysical and chemical data illustrate evidence of overgrazing and aridisation on the local level even when within a general context of increased precipitation.

The following segment, *Overgrazed Grasslands and the Emergence of Y.pestis Reservoirs and Potential Host Populations*, illustrates connection between overgrazed lands and population increases in the burrowing rodent population and the greater presence of *Y.pestis* and outbreaks of the Plague. The risk factors for a burrowing rodent population boom largely coincide with the risks for *Y.pestis* to thrive, leading to increased chances for a spreading of the pathogen to secondary hosts, as other mammals (including camels, marmots and goats) and humans.

The last section is the *Susceptibility of Livestock and Human Populations to Zoonotic Epidemics*, explains how the link to livestock and humans to zoonotic disease is increased as the rodent population boom escalates. This phenomenon is illustrated in contemporary Arabic documentation in the Mamluk Empire during the Black Death of the mid-fourteenth century. Additionally, the risk is further heightened if other secondary hosts are domesticated animals that have been infected with a zoonotic disease and people are in close proximity to these animals. This would increase the risk that *Y.pestis* adapts to human hosts. However, some fourteenth century peoples including the Polish, Irish Gaels, and the Bedouins of the Mamluk frontier relatively thrived during Black Death quite possibly due to different dietary dependencies and more adaptable socio-economic systems.

I. The Evolution of Empire: Socio-economic and ecological Development of the Mongols

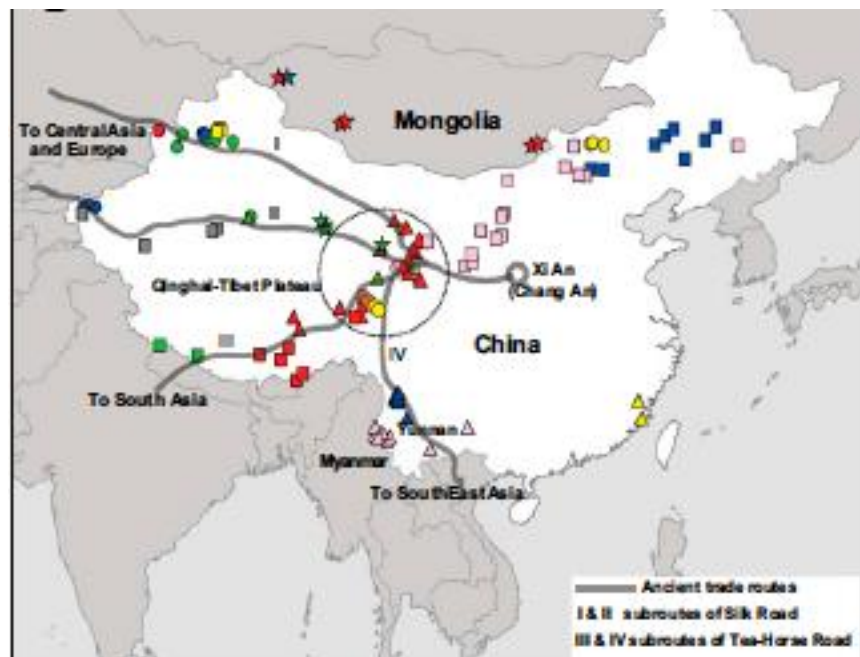


Fig.3.1. *Mongolian Epidemic and the Expansion of the *Y.pestis** Cui *et al.* (2013) map the ancient trade routes (grey lines signify trade routes) and “the circled area is the Qinghai-Tibet Plateau, which encompasses the most diverse isolates and may be the original source of *Y.pestis*” (Cui *et al.* 2013:578)

Historically, the Mongolians are thought to have brought *Y.pestis* from western China/Mongolia to Europe (Cui *et al.* 2013:578) Documentation of Mongolian soldiers suffering from an outbreak that could have been the Plague, mostly relate to the early to mid-thirteenth century (though there is some documented reference to a “dream” of an outbreak in 1273) (Hymes 2014:293). This is especially interesting as the Mongolian Empire pulled out of Hungary in 1242 and the Empire fractured into smaller states in 1259. The time of the expansion of the Mongol Empire coincided with the official documentation of the Jin Dynasty that indicates the Mongols were suffering from the most intense period of epidemics on record that occurred in 1232, and later outbreaks of 1235, and 1241 were documented in Song records (Hymes 2014:289-292).

The outbreaks in western China coincide with the Mongolian soldiers engagement in battles, including Muslims of the western Mongolian territories

(Hymes 2014:291). Conflicts with the Mamluk dynasty continued later, in and around present-day Syria, from 1260-1303 and this could have also been area where *Y.pestis* spread from. It is typically hypothesised that *y.pestis* was solely brought over by trade from China in the mid-14th century. However, Philip's notes in *Medieval Expansion of Europe* that "the actual volume of the eastern trade was surprisingly small" (Philips, 1998:97) he goes on to quantify this by illustrating the amount of eastern trade reaching its most popular port, Venice. Philips explains,

It has been said that in the fourteenth century the total amount of goods imported to Venice could normally be carried by three state convoys travelling once a year to Constantinople, Beirut, and Alexandria, representing in all only about 1,000-2,000 tons of merchandise. The significance of these imports was that, although they were generally small in volume, they were high in value and much in demand, so that the eastern trade assumed an importance out of all proportion to its material quantity (Philips, 1998:97-98).

This period was not characterised by long-distance Eurasian trade, but rather a transformed landscape with much greater emphasis on pastoral animals or the cultivation of cash crops that were often new to the region. Wheat was increasingly cultivated in Europe, along with citrus fruit along the Mediterranean, while grains as millet, sorghum, and especially rice became staples along with other crop introductions to address the import shortages of cultivated resources people in Asia and Europe had come accustomed to (Tabak, Faruk, 1996:23-48). This transformation of the Asian and European landscape to accommodate large herds and cash-crop cultivation made this enormous region more ecologically similar with fewer distinct boundaries that would have limited the expansion of opportunistic species that may played the role of host and spread *Y.pestis* to different regions.

3.1 Archaeology and Palaeoecology of the Capitals of the Mongol Empire: Evidence for large-scale trade and methods to transform landscapes

The Mongol Empire's beginning in Avargyn Balgas and subsequent expansion to Kharkhorum serve as indicators of the economic trading prowess and administrative, organisational, and skilled expertise that the Mongols' possessed even at the Empire's infancy. Avargyn Balgas is a key early settlement area that is

“still revered today as the homeland of Chinggis Khan and the Mongol royal lineage” (Honeychurch and Amartuvshin, 2006:269). Honeychurch and Amartuvshin go on to highlight the importance of the site in referencing historical documentation of Yuan dynasty (1260-1268A.D.), during Mongol rule of China that “indicate that the site was probably one of the earliest settlements constructed by the medieval Mongols and contained the main palace of Chinggis Khan, known as Ikh Ord.” (Honeychurch and Amartuvshin, 2006:269).

Avargyn Balgas is a settlement located northwest of the Avargyn River in northeastern Mongolia in the Three Rivers region of Khentii province. The site has been dated to having been in use from the 12th to the 14th century (Honeychurch and Amartuvshin, 2006:270). Archaeological evidence of the site has revealed the foundation of extensive architecture, fired clay roof tiles, tiled floors, glazed and earthenware ceramics, iron work debris, coins, roadways, earthworks and canal systems (Honeychurch and Amartuvshin, 2006:269-270). The faunal composition shifted “from a subsistence-based assemblage to one comprised mostly of specific horse bones known to have had ritual significance.” (Honeychurch and Amartuvshin, 2006:270). This change along with contemporary historical documentation of annual offerings in the Mongols ancestral homeland and the establishment of Kharkhorum as a new economic centre has led archaeologists to suspect Avargyn Balgas was transformed from an administrative centre to a ceremonial centre (Honeychurch and Amartuvshin, 2006:270).

This archaeological evidence shows that, even in the early days of the Mongol Empire, there had been significant settlement areas that were quite advanced in their skills in architecture, craftsmanship, construction, irrigation, and their understanding of promoting a cash economy (seen in the production of coin and the creation of wealth needed to construct Avargyn Balgas). As the Chinggis Khan’s Empire quickly grew, he established a new economic capital that had better transportation links to support further expansion. This new centre of trade was Kharkhorum.

The archaeological evidence of Kharkhorum shows that it was engineered for growing trade and was a larger, more technologically advanced version of Avargyn Balgas. This new capital provided key trade routes between south-

central and northern Mongolia, eastern and western Mongolia, as well as the Ongi and Tui river systems that were the most southernmost extensions into the Gobi desert. The ending of these rivers in the Gobi desert served as jump-off point to the southern trade routes. The city main period of construction was from 1220 to 1260 A.D. that included a city wall made of earth standing 5 to 8 metres high. This urban centre had specialised districts of craft specialists and administrative offices. The evidence of Kharkhorum's extensive trading networks included excavated cemeteries that show "burial practices from diverse parts of the empire" and artefact finds with objects from regions across Central Asia to North Africa. Trading centres, such as Kharkhorum, would also provide a justice system by accommodating mobile courts (Honeychurch and Amartuvshin, 2006:270).

An outpost of Kharkhorum, Den-Terek, was also excavated and "revealed evidence for intensive agriculture involving large-scale horse drawn millstones, canal systems, and remains of wheat, barley, and millet" Additionally, there was evidence of cattle, horse, camel, sheep/goat herding, in addition to the bones of other local wild species. Craft production also took place at Den-Terek including specialised iron working, stone carving, and textile production (Honeychurch and Amartuvshin, 2006:272).

3.2 Cultivation and ecology of Karakorum

The impact of trade on food supplies and the local ecology around Karakorum is readily seen as Rösch, Fischer, and Märkel found in their palaeoecological study at the archaeological site and found nearly 5000 plant remains identified. They noted that the list of food plants dated to the 13th-14th century "is not shorter than in most European medieval towns like Köln, Konstanz, Freiburg, Braunschweig or Lüneburg" (Knörzer 1987; Küster 1989; Sillmann 2002; Hellwig 1990; Wiethold 1995, Rösch, Fischer, and Märkle, 2005:486). The impact of these imported foods on the local Mongols seems substantial, and there is a remarkable geographic range that some of the food came from. Rösch, Fischer, and Märkel explain,

More than ten species of vegetables and spices indicate a high gastronomic level. Some of them were probably gathered in the wild, other perhaps grown locally in gardens, but most of them must have

been imported. The same holds true for the about 20 species of fruits and nuts, most of which were also found in European towns, but rather rarely and more frequently only in later periods...Whereas in Europe imported plants came from a distance of normally not more than several hundred km or less, the production sites of the imported plants consumed in Qara Qorum (Karakorum) were in China or central Asia to mention the most important areas; that is at distances of 1500–2000 km and more, separated from the consumer site by huge deserts” (Rösch, Fischer, and Märkle, 2005:486).

This capacity to import food only tells part of the story. The Mongols knew that they could not depend upon imports from distant lands for their livelihood and thereby understood the need to augment local food production. The transformation of the local ecology around Karakorum for this purpose quite pronounced as Lehmkuhl *et al.* (2011) observed while studying the site, “The strongest human impact occurred during medieval times when Karakorum was the capital of the Mongolian empire” (Lehmkuhl *et al.*, 2011:43).

Changes to the landscape occurred as the Mongols realised that they needed greater productivity of food to support their military expansion. However, this was not an easy undertaking as the area had little precipitation and long and cold winters. Rösch, Fischer, and Märkel explain the Mongol’s system of cultivation around Karakorum,

...we suppose local production of *Panicum miliaceum*, *Hordeum vulgare*, *Triticum aestivum* and *Setaria italica* as summer crops. The rather large size of the grains and the associated weeds—mostly sedges and Chenopodiaceae which indicate wet and fertile soils—indicate irrigation and fertilization of the fields. Fertilization with dung of livestock should have been no problem and water for irrigation was available in the nearby river Orchon. Due to low precipitation and especially the dry winter and spring, even the cultivation of spring and summer cereals is difficult to impossible without irrigation. Therefore it is most probable that the local cereal production was in irrigated fields. (Rösch, Fischer, and Märkle, 2005:488-489)

The evidence of vegetation reveals some interesting changes that were happening during the rise of the Mongol Empire. Cultivation was substantial and included the construction of irrigation canals, as Rösch, Fischer, and Märkel indicated above. It is also remarkable to note the decrease in grasses and trees during the time of the empire, as seen on Lehmkuhl *et al.* pollen diagram of Karakorum below.

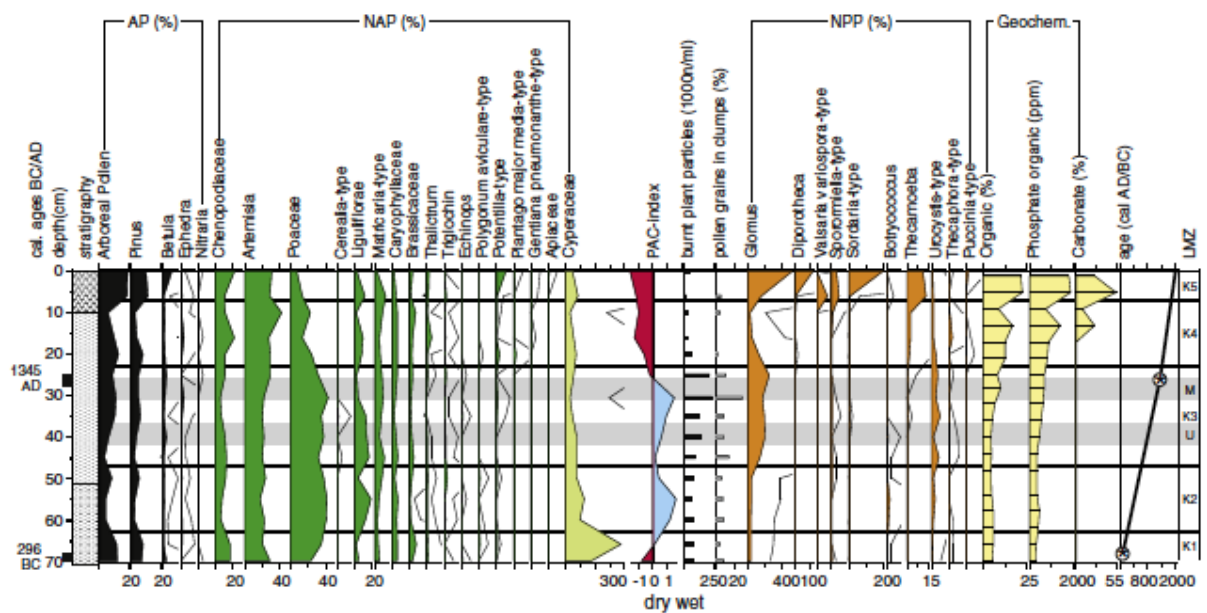


Fig.3.2. Lehmkuhl *et al.* (2011) explain their Multi-proxy diagram of Karakorum “with selected data of pollen, NPP and geochemical analyses. Consider different scales and units. AP = arboreal pollen, NAP =Non AP, NPP=Non-Pollen Palynomorphs, PAC-index=Poaceae/(Artemisia+Chenopodiaceae). K 1–5=Local Multi-proxy Zones (LMZ), U and M=times of the capitols of Uighur and Mongols at the Orkhon. Stratigraphy (bottom to top): grey clay with fine sand; grey silty clay; clayey silt, upper 20 cm brownish, humus, 20–52 cm rich in iron concretions” (Lehmkuhl et al.,2011:41)

It is noteworthy to highlight the steady increase of Phosphate organic material compared to the increase of organic material, which climaxes sometime before 1345A.D., c. late 13th century. The fact that phosphate organic material keeps on increasing through this period may be a sign that average herd size continued to grow in size and density (leading to greater fertilization of the fields), while the area of vegetation decreased. This decline is seen in the pollen diagram as Poaceae takes a sharp decline from the c. late 13th century and a substantial decline is also seen in tree pollen from approximately the same date.

Therefore, it should be considered that the decrease in wetness, also around the late 13th century, may indeed, at least in part, be caused by the lack of vegetation cover. Since vegetation cover is a key factor in diminishing evaporation from wetness and moisture in the soil, the dramatic decrease in Poaceae that was not seen in the previous 1,400 years. Approximately 900 years before the wet climax of the c. the late 12th century, the previous dry period, c.

250 B.C., did not show a significant difference in organic material. Rather the tree pollen was more present and did not show much of a decline (in percentage to the pollen count of other vegetation) until the wet period had already commenced and the Poaceae count continued its increase from the end of the dry period. Fernández-Giménez *et al.* make the observation that the causes for these impacts on the vegetation record may be due to livestock grazing and increased precipitation.

...from the Mongol Empire forward, the paleo record reveals human impacts on the landscape, including changes in plant species and erosion that could be associated with grazing. These impacts could indicate a feedback from the precipitation-driven expansion of the Mongol Empire to the environment via increasing stock densities, especially in areas near centers of political power like the Orkhon Valley 9 Fernández-Giménez *et al.*, 2017:37-38).

Though Fernández-Giménez *et al.*'s suggestion of "the precipitation-driven expansion of the Mongol Empire" assumes that increased wetness of the soil is caused by greater precipitation, which is not necessarily the case (will discuss in more depth later), the increased impact of herds would seem possible as with the Mongol expansion to new lands they would have needed to bring herds with them for a source of food and as pack animals. The impact of the Mongol accumulation of greater herds in Mongolia and the intensification of grazing in new lands, potentially surpassed the carrying capacity of the grasslands, and encouraged deforestation. Lehmkuhl *et al.* (2011: 38) illustrate that since the mycorrhizal fungi *Glomus*, which avoids wet conditions that are present in their core sample that has been tied to the period of the Mongol Empire, is an indicator of the input of eroded soils. Evidence of deforestation (high concentrations of charcoal) as well as high grazing pressure (seen in frequently occurring pollen clumps) were quite evident during the Mongol Empire, but greatly diminished after the fall of the empire. Lehmkuhl *et al.* (2011: 38) explain,

LMZ [local multi-proxy zone] K3 (42–23 cm, 500–1400 AD). This reflects stability of the dominating vegetation types under still humid conditions. By contrast, the spectra of LMZ K3 are characterized by high concentrations of particles of burnt plant material ("charcoal particles") of up to 250,000 per millilitre and high values of *Glomus* (240%). Since the mycorrhizal fungi *Glomus* is part of the rhizosphere and avoids wet

conditions like those of the profile site, the spores indicate the input of eroded soils. Both proxies may reflect an increased use of wood as fuel in the nearby capitals of Uighur and later Mongolian Empire as well as increased livestock breeding. In addition, a higher grazing pressure is documented by the more frequently occurring pollen clumps, spores of plant parasitic fungi (Urocystis-, Thecaphora-type) and spores of coprophilous fungi (Sporormiella-, Sordaria-type). Pollen of the Cerealia-type may originate from the irrigated fields mentioned to be located somewhere around the Uighur capital at that time. From the time of the Mongolian Empire, even archeological findings of Cerealia are known (Rösch et al., 2005). The local replacement of green algae (Botryococcus) by thecamoeba¹⁵ indicates progressing aggradations of the bayou. At the onset of LMZ K4 (23–7 cm, 1400–1800 AD) decreases in Poaceae (13%), in the PAC-index, in Glomus and in the concentration of particles of burnt plant material all suggest an expansion of dry steppe and a reduction in human influence after the destruction of the Mongolian Empire (Lehmkuh et al., 2011:38).

Lehmkuhl *et al.*'s findings at Karakorum illustrate that through deforestation, overgrazing, and possible erosion from irrigation of cultivation of cereals resulted in sediment accumulation, as seen by the local replacement of green algae by thecamoeba. Karakorum shows evidence of ecologically unsustainable practices that brought about the conditions for flooding and water erosion that resulted in sediment accumulation. Thus, we cannot assume that increased precipitation was the reason for greater wetness in areas taken by Mongols. However, if deforestation, over-intensive agriculture, and/or overgrazing of the grasslands did indeed occur, then there would have been ecological consequences leading to greater vulnerabilities in food security and disease for the people and the livestock depending upon the land.

II. Why did these ecological issues develop in Karakorum while the Mongols were growing into an Empire?

3.3 The foundation for socio-economic change to support imperial ambitions

Eight years after Chinggis Khan united the Mongol tribes after decades of war, he led an invasion of North China against the Jin Dynasty. The Mongols were never a people of a large population and always depended upon the submission of

other leaders to be part of their empire. Therefore, the Mongols required different alliances, including with the powerful Song dynasty in order to finally defeat the last Jin emperor in 1234. However, then the Jurchen people (of the former Jin Dynasty) became increasingly influential with the Mongols. If the Mongols were going to form an empire, they needed to learn how to govern a vast territory. The expertise of the ex-Jin officials were certainly needed and the Mongols integrated many of the Jin concepts of governing and military organization. (Atwood 2004: 509).

After the Song helped defeat the Jin Dynasty, albeit a bit belatedly, the Mongols quickly turned against the Song. The Song had great advantage over the Mongols in the number of troops in the war, which continued on until the Mongols eventually defeated them in 1279 (Atwood 2004: 509). Though ex-Song officials that assisted the Mongols were few and far between (Atwood 2004: 509), it seems between the Jin and Song, the Mongols had decades of long wars that forced them to learn from their enemies in order to defeat them. In the verse of the ancient Chinese general, Sun Tzu, "Know the enemy, and know yourself, in a hundred battles you will never be in peril," (Sun Tzu, 1971: 84) must have come into play here as the wars with the Jin and Song were very different than the earlier tribal wars. The emphasis on learning about over those they were trying to rule over may be seen just in the number of Chinese historical texts that were translated into Mongolian (Atwood, 2004: 609). There is evidence of the Mongol transformative adaption of organizational structures and institutions of their adversaries, or former adversaries, , especially with the Jin. This is exemplified by the Mongol adoption of the social organization of the Jin where "the military was built around a militia of Jurchen households and their slaves organized into a decimal organization of 100s and 1,000s" (Atwood 2004: 175), which was implemented by the Mongols where the people they ruled over were broken down into geographic areas that they were not allowed to leave with a military commander in charge of each large, umbrella unit, the *thousand*. Each of these military commanders was the subordinate of the imperial family, thereby centralizing their control in military bureaucracy (Atwood 2004: 277-278). The Jurchen were also agricultural settlers, which may have led to the irrigated

cultivation in Karakorum. This would not have been something that would have been easy for the Mongols to assimilate, as culturally they looked down upon agricultural settlers and as well as being bitter enemies with the Jerchen in the late twelfth century (until the Mongols defeated them in 1234). However, the Mongols needed to find ways to quickly raise the resources needed for their military expansion. Taking censuses of agricultural settlers was a valuable practice to gain substantial tax revenue, which is not something that would have had much exposure to previously.

The administration of the empire increasingly depended upon ex-Jin officials, at first for their taking over such positions and later, especially under Ögedei Khan Yelü Chucai in more fully integrating Jin administrative systems and institutions into the functioning of the empire (Atwood 2004: 278). Additionally, the centralization and administration of the Yüan Dynasty was adopted to Chinese culture and organization through the integration of Confucian exam system for administrative positions was later adopted in 1315, seemingly following the “Song neo-Confucianism as the guiding ideology” (Atwood 2004: 509). The substantial influence of Confucianism is also seen by the considerable Confucian text into Mongolian. The Yüan Dynasty also followed previous dynasties in issuing its own paper currency, which unlike that of its predecessors, was based upon silver, giving it greater acceptance and wider appeal (Von Glahn 1996: 56).

The Mongols also had the task of ruling over groups of people that lacked a political unifying leader. Tibet and Persia (of the geography approximating present-day Iran) are two examples of this, which the Mongols had different solutions to, but they both depended upon religious leadership to legitimize Mongol presence (though only eventually took place in Iran in 1295) while also being able to integrate with the culture of the people they were occupying. These actions gave them greater and more peaceful means to being able to further tax the people. In the case of Tibet, the Mongols became patrons of many lamas that offered a mutually beneficial relationship that both promoted certain sects of Tibetan Buddhism, especially Amdo, in turn for the lama’s assistance in legitimizing Mongol presence there. This allowed the Mongols to take greater measures of control without devoting many soldiers or resources to do so. One

important example in Tibet of such a measure was conducting a census, which led to greater taxes and having political leadership geographic districts. This was quite a feat for as the Tibetan people were splintered into tribal political leadership after the fall of the Tibetan Empire c.900A.D. The fall of this empire also brought forth the demise of the Buddhist temples, with very few surviving. However, this began to change in the tenth century with the building of Buddhist and Bön temples, especially in the Northeast Tibetan Plateau. It certainly seems that the Mongols would have had an easier time integrating with Tibetan Buddhism as its ancestral religion, the Bön faith, would have had similarities to their own. This Bön faith (the priests are known as Bonpo) is a pre-Buddhist religion where, according to Kværne, (1996: 9),

...the rituals performed by the ancient Bonpo priests were above all concerned with ensuring that the soul of a dead person was conducted safely to a postmortem land of bliss by an appropriate animal—usually a yak, a horse or a sheep—which was sacrificed in the course of the funerary rites...The purpose of these rites was twofold: on the one hand, to ensure the happiness of the deceased in the land of the dead, and on the other, to obtain their beneficial influence for the welfare and fertility of the living. (Kværne, 1996:9)

However, Kværne (1996: 10) also stated that religion had a rebirth in the tenth and eleventh centuries, which was said to have been re-introduced to Tibet from India and took a form that is much more similar to Buddhism. Nevertheless, considering the Mongol belief in the sanctity of horses, it is understandable why they could identify with the Tibetans' religious beliefs. This ability to integrate with the Tibetans would have helped give the Mongols the opportunity to subjugate the Buddhist lamas as moral authorities and leaders to influence Tibetans and regional peoples.

3.4 The Development of Northeast Tibetan Plateau and the Tibet Buddhist Sects

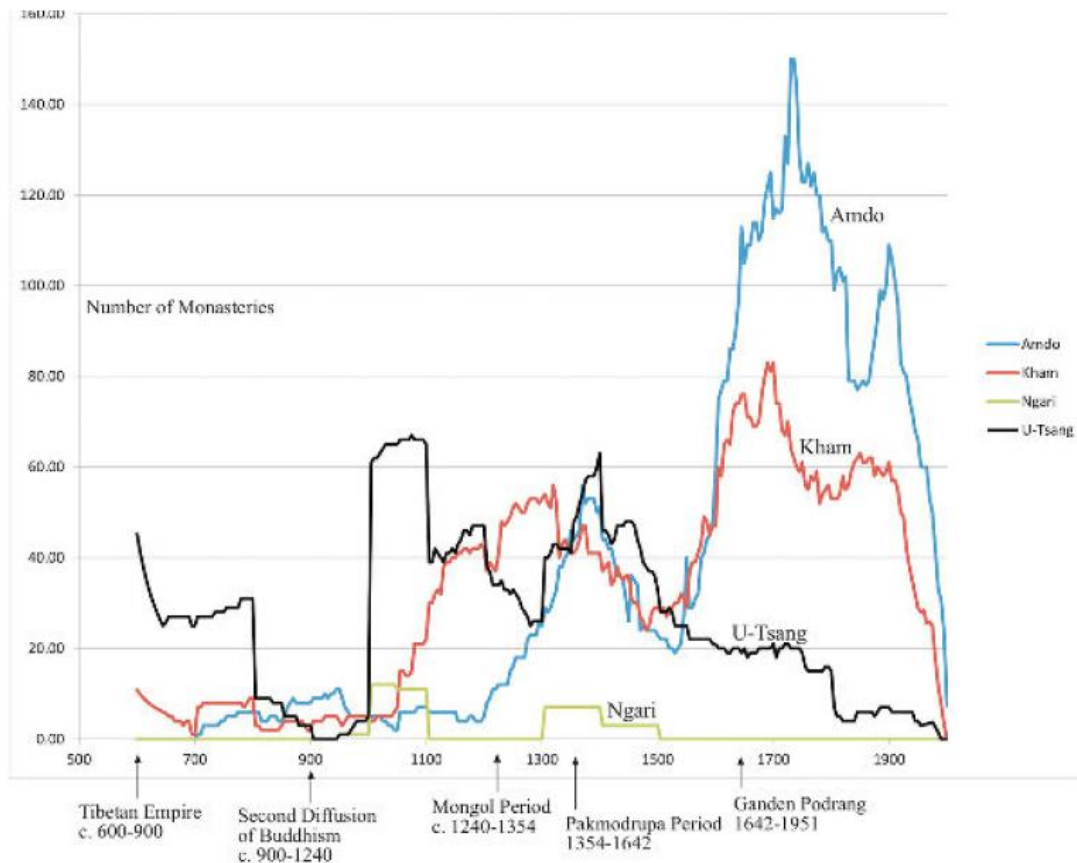


Fig.3.3. Construction rates of Buddhist temples of the four Tibetan Schools: U-Tsang, Ngari, Kham, and Amdo (Ryavec 2015:16)

After the fall of the Tibetan Empire, the Ngari and U-Tsang no longer had any temple building. However, the Kham and Amdo continued at about the same, albeit low rate that was seen during the empire. Then by the late tenth/early eleventh century all four Buddhist sects as well as Bön were building temples. This rebuilding process of Buddhist (as well as Bön) temples were especially concentrated in the Northeast Tibetan Plateau, as Ryavec (2015: 84) explains,

While all four of the main schools or sects of Tibetan Buddhism (Nyingma, Sakya, Kadampa, and Kagyu) established some temples or monasteries in the greater Tsongkha region during the Second Diffusion, the temples of the Bonpo were the most numerous and widespread...These Tibetan Buddhists and Bonpos would also have come into greater contact with Chinese Mahayana Buddhist schools, because frontier Chinese walled towns, such as Minzhou and Lanzhou, already had centuries-long traditions of active Buddhist monasteries. The Silk Road oasis town of Liangzhou was even under Tibetan rule during the late tenth and early eleventh centuries

The Northeast Tibetan Plateau region claims to have been “an incubator for either lost or initial Tibetan monastic traditions and is corroborated by postimperial trends in Buddhist temple constructions” (Ryavec 2015: 84). The proximity of the Northeast Tibetan Plateau to the Chinese Mahayana Buddhist schools and established trade routes, may have been a compelling draw to the Buddhist sects to establish temples in the region. Subsequently, if these institutions indeed became established in the region with trade of those in the Jin and Song Dynasty’s where greater wealth production was being exploited, it would follow that an economic transformation in the region may have taken place fostered by these Buddhist and Bonpo temples. However, where there is wealth there is also the greater incentive for war. The region may have indeed been increasing in its trade and wealth, but as the map below illustrates, the twelfth (as well as the thirteenth) century were rife in conflict, particularly between the Jin and Song dynasties.



Fig.3.4. Amdo circa 900-1240: The Tsongkha Kingdom, and Religious sites Founded during the Second Diffusion of Buddhism. The Second diffusion of Buddhism and different political forces around the Northeast Tibetan Plateau(Ryavec 2015: 84)

The Tongkha Kingdom, which was a tribal confederation, was considered the most powerful political entity in the region, but it ended around 1100, under the Song dynasty. The Song took over the region and “built or took over key forts

and walled towns in the major river valleys” (Ryavec 2015: 83) The movement in of the Song and their occupation of walled towns signifies a socio-economic shift was likely happening during the period, from the Tibetan herding cultural economy to one of greater settlement agriculture. The Mongols, however, were continuing their wars by proxy as well as with their own forces to chip away at the region while establishing strong relationships with the Tibetan lamas. However, the experience in Persia was much more direct, though the Mongols needed to integrate to sustain their presence in the region.

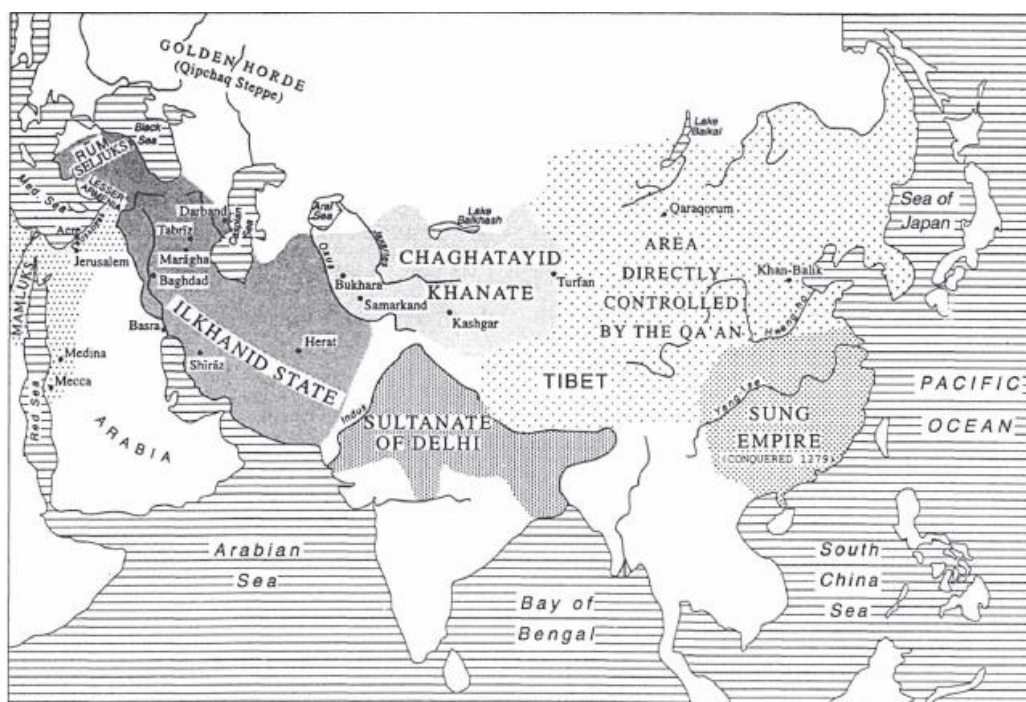


Fig.3.5. Mongol Expansion to Persia and the Establishment of the Ilkhanid State Map. Asia after AD 1260 of territory under Mongol and Mongol Khanate Control (Amitai-Preiss,1995:236)

3.5 Asia after AD 1260 of territory under Mongol and Mongol Khanate Control

The early Mongol presence in Persia did not take the form seen in Tibet, however, and it took some time for the greater Mongol integration that took place under Ghazan. Though the Mongol presence was by invitation from the Persian nobility, with their aim of an integrated joint administration (Lane 2012:

267). However, Hüle'ü, the brother of the Khan, Möngke, himself a Buddhist, lacked the will to integrate as he took power of the Islamic land in 1256. His harsh tactics quickly had a toll on the region, as Petrushevsky (1968: 483) explains:

The first period—from the twenties to the nineties of the thirteenth century—is marked by the colossal economic decline of Iran, caused both by the devastation wrought during the Mongol conquest, and still more by the administrative practices, in particular the taxation policy, of the first conquerors (the viceroys of the Great Khan, and then from 1256 the Īl-Khāns). Typical phenomena of the time are a reduction in population and cultivated land, the decline of agriculture, the migration of fresh multitudes of Mongol and Turkish nomads, and the expansion of migrational cattle-breeding, a decline in urban life, the growth of tendencies of natural economy, an increase in state taxes and feudal rent, the attachment of peasants to the soil, and the growth of a peasant insurrectionary movement (Petrushevsky, 1968:483).

The Mongol's socio-economic systems were forced onto the Persians. It was obvious to many Mongol elite that they had to be more integrated with those that they ruled over if they wanted to sustain their position. The difficulty being that the Mongol ruling class did not allow any outsiders in, but rather it was a core of Mongols that ruled, and Hüle'ü was the brother of the khan. This right to rule was emphatically not integrated since the Baljuna Covenant, when Chinggis Khan reportedly said to his followers before the Mongol tribes united, "All those who drank this water with me, I will employ in office from generation to generation" (Atwood 2012: 35). Therefore, the right to rule followed the generational descendants as a hereditary right. Thus, integration of culture and power was difficult for some to adapt, even when it was in the best interest of the empire to do so. Therefore, the harsh conditions that Hüle'ü intensified continued until the 1290s. Though he established a joint administration with the Persian nobility, but his harsh taxes increased people's distrust of him. Wassaf, a contemporary historian and state accountant illustrated the impact these harsh measures may have been a worse attack on the people than the previous war:

...no money remained in the treasury because in that year (1295) in the course of eight months three rulers had succeeded to the throne and twice in the far corners of the empire there had been large military expeditions, inevitably demands for payments in advance and extraordinary levies were made and mavashi had been taken at the rate

of 20% in most of the tax districts, especially in Fars. 32 [Tārīkh-i Wassāf p.326]

Wassaf's experience did begin to change with the reforms of Ghazan, who brought in the Muslim faith as his own. These reforms took place within a context of much greater integration where Ghazan became a Muslim leader himself, which offered him much greater acceptance and a thriving economy.

The second period-From the nineties of the thirteenth century to the middle thirties of the fourteenth century (to the death of Īl-Khān Abū Sa'īd in November 1335) is characterized by something of an economic upsurge, especially in agriculture, as a result of the reforms of Ghazan. During this and the following periods conditional private ownership of land and large-scale unconditional landownership expanded at the expense of state and small-scale peasant landowning. (Petrushevsky, 1968:483)

This prosperous age did not last long. The main reason probably was taxes. As Petrushevsky (1968: 533) stated, "The system of taxes and services of the Il-Khān state was without a doubt based on the merciless exploitation of the settled working population by both the state and the feudal leadership connected with it. The scale of feudal rent and taxation was completely out of proportion with the economic development of the country." Possibly the desperation of the Mongol's short-term desperation in continuing to have sufficient resources to sustain their long military ventures and vast empire. Whatever the case may be, the toll on those the Il-Khān ruled over was often devastating. For instance, "In 707/1307 the general Muhammad Sam demanded 500 kharvars of grain, 500 rams, 50 horses, 30 slaves {barda} and 10,000 dinars for his army from the vassals of the lord of Heart" (Petrushevsky 1968: 533).

3.6 The Uncertain Frontier

The Asian steppe is sparsely populated and was, in general, as land of herders. Even though the Mongols would send scouting teams ahead to find the route that had sufficient grazing lands, (Sinor, 1972:177-178) there was little room for great adaptability and flexibility with the cavalries that brought huge herds with them that they were bringing through the conquer new lands. Sinor illustrates,

The locating of pastures sufficient to provide subsistence for big armies was no mean task, and the Mongol quartermasters had their hands full.

When in 1252 the great khan Möngke prepared for his great campaigns of conquest, quartermasters, "elchis were sent on in advance- records the Persian historian Juvaini - to reserve all pasturage and meadowland wherever the World-King's troops might be expected to pass, from the Qanghai mountains between Qara-Qorum and Besh-Baligh; and all animals were forbidden to graze there lest the pastures might be harmed or the meadows injured. And all the garden-like mountains and plains were banned and prohibited and the teeth of the cattle were prevented from browsing thereon". In 1303 the il-khan Ghazan had to postpone his attack on Syria because of the enemy having set fire to all fodder so that the Mongols' horses should find nothing to eat, Ghazan decided to postpone his campaign until spring "when the young grass would begin to sprout" Sinor, 1972:177-178).

The point of finding grazing land for the great Mongol cavalries often in the midst of other herding peoples or in uncertain terrain is important to highlight as it was not possible that the Mongols brought fodder for their horses on these military campaigns. Sinor calculated this impossibility in citing a 19th century Chinese text documenting a horse's daily grain intake and a camel's carrying load in stating, "almost fifteen hundred camel-loads of grain would have been needed to feed a hundred thousand horses for one single day" (Sinor, 1972:183). Thus, the Mongols did not have much room for adaptability and flexibility during these military campaigns. Fletcher further illustrates this with the Mongols invasion of the deserts of the Middle East, "(The Mongols) entered the desert habitat suddenly, en masse, in centrally-planned campaigns, phases of a concerted and temporary effort. There was no time for them to acculturate themselves to the desert habitat" (Fletcher, 1986:42)

The Mongols had a tradition of raiding and short-term occupation as a military strategy that can be seen repeatedly in their early empire. However, maybe part of the reason for raiding and leaving those that they occupied was due to a lack of resources that would have been needed to sustain their cavalries and the huge herds of horses and livestock they brought with them. Atwood (2004: 350) explained, "The Mongols disliked fighting in either the late spring, when the horses were weak due to exertion and poor fodder, or in the full summer, when they were fat and out of condition (qadaq)" (Atwood, 2004: 350). The importance the Mongols put on adequate grazing land or fodder for their horses should not be underestimated, as "...to eat before seeing to one's horses' needs in

the evening [was a] capital offense..." (Atwood 2004: 349).

3.7 Organised Militarisation

The goal of the Mongols when conquering an enemy was not to take over their territory or plunder their property, but to gain full submission of the territory's leader. Full submission would mean the Mongols desired:

- 1) the ruler's personal attendance at court;
- 2) dispatch of sons or younger brothers as hostages;
- 3) a census;
- 4) a supply of soldiers for further Mongol conquests;
- 5) payment of tribute;
- 6) appointment of a Mongol Darughachi (overseer); and
- 7) maintenance of the Jam (postal relay). (Atwood 2004: 249)

However, by just subjecting a leader over a territory meant that the Mongols did not have to deal with the people that lived there. Instead they were able to squeeze the leader and his people without having to face direct consequences of the angry people. The Mongol taxes on the people were often debilitating and brutal. (Atwood 2004:354)

The centralised system of administration and control was interwoven with the needs of the military and were ultimately led by military commanders. The most basic and stable administrative unit were the *thousands*, which were geographic-political entities that had certain geographic limits and resources that the people that lived there were bound to and were expected to regularly contribute to the Mongol cause through a tax that required a certain amount of horses, livestock, and/or animal/agricultural product commodity (Atwood, 2012:37). Atwood described how these geo-political units served the ruling family,

From above (the *thousand*) was the appanage of a family entrusted with it as a permanent reward for services in assisting the founding of the new order. The appanage was expected to provide both services to its particular ruling family as well as taxes and men ready for military and other services for the imperial court. From below it was a hereditary, closed community, within which resources were held in common, under the direction of the ruling family, and which was expected to manage its pasture and water resources in ways that enabled it to continue its appanage service (Atwood, 2012:37).

Each *thousand* was broken down into smaller units, and the local units would record the people in that unit in a *Blue Notebook* (Atwood, 2012:36). People were tied to the geographic area they were assigned to and could not leave (even very rare for those of high positions). However, since the Mongol expansion was happening at a very rapid pace and with each additional conquered territory came the extraction of resources, particularly horses and livestock, which would need grasslands to graze. The needs of the military would lead to re-distributions of people, horses and livestock, which resulted in the local administrative units often in a state of flux. However, the administration of the *thousands* remained relatively constant as each military commander would determine if any changes were needed within these geo-political units based on the military plans and objectives that they had. The Khan and the ruling clan had established their power over the commanders of the *thousands*, and this hierarchical system would work its way down to the local level, albeit without the direct oversight over most local people (Atwood, 2012:34).

III. Ecological & Biological Impacts of Expansion

3.8 Ecological Sustainability & Carrying Capacity through Traditional herding Socio-organisation and the Mongol Centralised Military Complex

Tribal herders have traditionally paid extremely close attention to carrying capacities and how to sustainably exploit them. The Mongols were no exception of this, as William of Rubruck observed in the mid-thirteenth century,

...every chief ('capitaneus') knows, according (to whether) he has more or fewer people under his power, the limits of his pasture land and also where he can graze herds in winter and summer, spring and autumn. In particular, in winter they go down to the south to warmer countries, in summer they go up to the north, to cooler (ones). In the places convenient for pasture but without water, they graze the herds in winter when there is snow there, because the snow serves them instead of water" (Nedashkovsky, 2014:297).

However, these tribes also put a premium on movement to adapt to the different seasons and ecological changes that might occur and they paid much attention to these changes. This was not the situation of the Mongols in the early-mid 12th

century. The Empire was quickly expanding and their military needs were of upmost concern, not changing ecologies. Through a strong military, they could conquer other peoples and take the food that they grew or herded, and therefore would have supplanted concerns about sustainably maintaining grasslands. If they needed more grasslands, they could just conquer other lands. Additionally, decision-making was centralised by the Khan and the ruling family could not have sufficient knowledge of the status of local ecologies to which they were sending their commanders who were in charge of the *thousands*. Likewise, commanders had to first and foremost follow the orders of the Khan, and they too might not have been very knowledgeable of the ecological conditions of local unit's grasslands. These large geo-political areas were essentially the military and military support apparatuses, which is very different than decisions being governed by a herder and the demands of his herd (Atwood, 2012: 34).

As noted earlier, the Mongols greatly encouraged agriculture within their empire, but it is not clear how this was arranged in terms of taxes and how this affected grazing lands. Certainly, the expansion of agriculture would have restricted pastoral lands and led to some deforestation and more use of hillsides for agriculture or grazing. However, as the Mongol expansion took place so rapidly, with ever increasing sizes of cavalry forces and livestock populations moving across landscapes would have made local adjustments difficult in order to ensure adequate grazing grounds were available for these huge herds. Bold estimated that there were 21.8 animals per person in Mongolia alone in 1220 and over 15 million animals in total (Bold, 1998:245-246). Below Atwood illustrates the differences in large private herds held in Mongol territory.

Table 3.1. 1188 are the Imperial Herds of the Jin Emperor; 1773 is the private herd of Jibzundamba Khutugtu; and 1835 are the private herds of 21 zasag [ruling] nobles and 2 Khuttugtus of Setsen Khan Province. Note the high percentage of horses in 1188, which were necessary during war for a cavalry (Atwood, 2015:329).

Year	Horses	Camels	Cattle	Sheep & goats	Total
1188	470,000 31.9%	4000 0.2%	130,000 8.8%	870,000 59.0%	1,474,000
1773	24,709 20.8%	2015 1.7%	3634 3.1%	88,252 74.4%	118,610
1835	18,253 23.0%	1285 1.6%	7355 9.2%	52,634 66.2%	79,527

How much this population expanded since that time is difficult to know, but as mentioned earlier, the herd quantities of the Mongols were of tremendous sizes that served them in times of war as well as their frequent trading of the animals. This may have led to overgrazing of the lands that the herds occupied. Atwood (2015) argued that two distinct versions of herding existed in the Asian steppes, Imperial itinerance and mobile pastoralism. Mobile pastoralism is a herding system that moves the herd based on ecological considerations in regards keeping his herd fed with sufficient grasses and safe, whereas imperial itinerance brought forth other priorities. Atwood explains,

Imperial itinerance, as a form of movement practised by ruling elites in steppe states, thus seems to be a separate phenomenon from known varieties of mobile pastoralism...it seems that projection of imperial authority was certainly a significant part of the purpose (for imperial itinerance). To that extent, 'nomadism' (i.e. itinerance) was not just a way of avoiding power; it was also a way of projecting power. This form of imperial itinerance was as much an instrument of projecting state (and class) authority as it was a way of avoiding the authority of hostile states (Atwood, 2015:333).

Herding as a show of power certainly is not deemed as a traditional function of herding, but since the Mongol Empire had such huge herds it was effective in intimidating opposing forces. However, when other factors take priority over the well-being of the herd, then the herd is put more at risk. William of Rubruck described a pastoral path that Möngke Khan was leading his herd on:

[The Khan] himself moved on around Passion Sunday [29 March 1254] with the small dwellings, leaving the large ones behind. . . . He passed through mountains where there was a powerful wind, the cold was intense and the snowfall heavy, asking us to pray to God to alleviate the cold and the wind: for all the livestock in our train were at risk, especially since at this time they were carrying young and producing. (Atwood,

Möngke was following the established round of Ögedei Khan, so this was not an account of a unique event. Atwood rightly observes, "...pushing weak and calving livestock into rapid movements uphill was obviously dictated by considerations entirely independent of mobile pastoralism" (Atwood, 2015:307-308). As Atwood later notes, the pushing of herds to move quickly is not advantageous for their health or market value (Atwood, 2015:332). Rubruck's account illustrates that other concerns outweighed the risk to the herd's safety. It is also interesting that at least some of the elites may have been indifferent to the markets for pastoral goods, as the following observation by Rubruck seems to indicate,

The great lords own villages to the south, from which millet and flour are brought to them for the winter. The poor provide for themselves by dealing in sheep and skins. The slaves fill their bellies with dirty water, and with that rest content. (v.1; Jackson & Morgan 1990: 84)

This observation indicates the lords may have even preferred agricultural products over pastoral goods, which begs the question, did agriculture have favoured status in the empire? Since the Mongols did push agricultural cultivation for surplus wealth for the empire, it is an important question in attempting to understand how it was taxed and organised alongside grazing lands. It is apparent that other concerns outside of the sustainable use of grasslands to feed their herds were often the priority. The intensity of Imperial itinerance may have indeed conflicted with the priorities of sustainable management of grazing lands, as Atwood illustrates further,

...the descriptions of Inner Asian courts given by observers such as William of Rubruck at the court of Batu (xix.4: Jackson & Morgan 1990: 131) emphasise the vast numbers of persons that such courts drew together on an on-going basis. Similar such vast courts appear frequently in the history of Inner Asia, at least if designations of guards units, such as the 10,000 keshigten, or the Kitan dynasty's ordo with their 10,000–20,000-strong 'Heart and Belly Guards' (Secret History of the Mongols or SHM §224–34, 278; Wittfogel & Fêng 1949: 509–17) are anything like the reality. Research on Inner Asian mobile pastoralism has long emphasised the need for dispersal of herds to achieve optimal use of pasture resources, but with this sort of mob grazing (International Rangeland Congress 2008: §IV.16 [p. 48]), even granted the use of widely dispersed satellite camps, it would seem hard to avoid a harmful trampling and over-grazing near the imperial court. Political tensions, by restricting the utilisation of satellite camps and inhibiting mobility, would only further

increase the negative impact of such mob grazing methods on the pastures. (Atwood, 2015 :325-6)

The potential for overgrazing the lands of the Inner Asian courts is great, as Atwood above illustrates. Not only is the density and population of the cavalry units, high, but as indicated previously, the priority is not focused on the sustainable use of grasslands for their herds. This circumstance is also felt in the high concentrations of the *thousands* where human camps would be set up for a substantial length of time and health issues may have indeed been a concern:

One may also raise the question of whether concentrations of thousands within a space of 12–16 km or so did not raise problems of waste disposal and the potential for the spread of childhood and other infectious diseases. As Simukov noted, garbage build-up (let alone human waste) frequently sparked moves even in the Khangai where they were not necessarily needed (Simukov [1929] 2007: 362; Endicott 2012: 37–8). This problem, like the numbers camped in one place, must have been orders of magnitude greater in the large ordo camps. The result may well have been to make movement—and staying away from areas once camped on, until they were no longer pathogenic—a valuable practice in itself. As noted by William of Rubruck, the Mongols strictly observed a custom never to go back by the same way they came. Moreover, when the camp has been sited in some place, once it has moved on nobody will dare to pass, either mounted or on foot, through the locality where it lay, as long as there are still visible any traces of the fire lit there. (xxxii.10; Jackson & Morgan 1990: 225) To a degree this taboo may, like the taboo among the Monguors or some Inner Mongolians on hunting marmots, for example (Jagchid & Hyer 1979: 99; Schram 1954: 117), be related to observations of the spread of disease in unhealthy environments. (Atwood, 2015 :334)

The high density and populations of the herds in Mongolia have been illustrated here and the vulnerability factors of a zoonotic disease epidemic has been increased under the centralisation of the Mongol Empire and the geo-political *thousands*. McMichael's vulnerability factors for a zoonotic epidemic noted earlier included *Altered habitat, with proliferation of reservoir or vector populations, Intensified farming and animal husbandry, and Niche invasion*, (McMichael, 2004: 1054-1057) which seem especially relevant in regards to the ordo camps and with the *thousands* in general. The intensified animal husbandry certainly was a niche invasion of its own in these small political-geographic entities, but they undoubtedly brought commensal rodents and organisms with

them. The grazing intensity would have altered the vegetation as non-edible plant-life would have thrived while grasses and other edible vegetation would have become increasingly sparse.

3.9 Carrying Capacity Problem in new Mongol Territories?

North China and the Northeast Tibetan Plateau

The evidence of erosion in Kharkhorum in central Mongolia, extends to North China and the northeastern Tibetan Plateau. Actually, the over-exploitation of lands in North China has some history that well predates the Mongol Empire. The evolution of this process begins in the Loess Plateau, which has had a rapid increase of sediment rate from the seventh century under the Tang Dynasty (618-907A.D.) and continued under the Song Dynasty (960-1279) (Jiongxin 2001: 7; Xu 2003: 3368). Jiongxin (2001: 7) below illustrates the historically documented number of bank-breaching events of the lower Yellow River correlated with the humidity index. Note that increases of sediment loads heighten risk of such events (Wang *et al.* 2007).

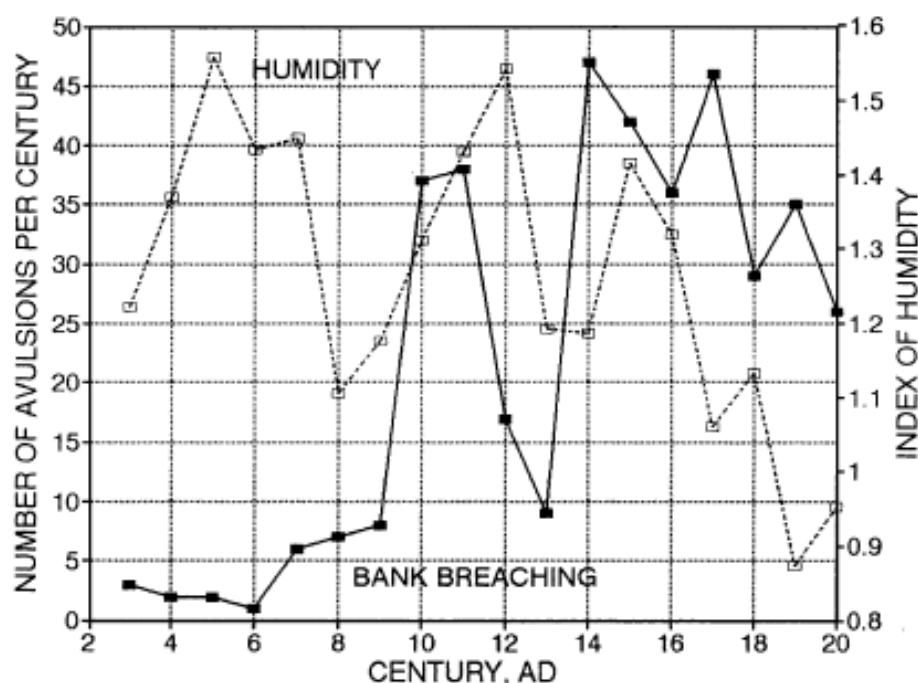


Fig.3.6. Historically Recorded Lower Yellow River Bank-Breaching Events in Relation to Humidity:Historical relation between frequency of bank-breaching of the lower Yellow River and the humid index. (Jiongxin 2001: 7)

Notice that the number of historical recorded bank-breaching events remain low until the seventh century even though the humidity level is generally at historically high levels. The documentation of these events dramatically rise from the ninth to the tenth century, going up slightly in the eleventh century, and then plummet in the twelfth century, even though there is a peak in the humidity index. The number of incidents of bank breaching decreases again in the thirteenth century, only to peak in the fourteenth century, while the humidity index falls. It should also be noted that the documentation rate of such incidents may have been effected by the frequent wars in the twelfth and thirteenth centuries. However, Jionxin (2001: 7) points out “although an overall tendency exists [between humidity and number of bank breaching events], the correspondence of the points in the two curves is not so good. This is because that besides the influence of climate, other factors including human activities also played a role.” Jiongxin (2001: 8) later continues,

Before the Tang Dynasty, the change in vegetation was controlled mainly by climate changes; since the Song dynasty the change in vegetation was controlled by human activities, and climate changes played only a minor part. The Tang Dynasty...was a period of great prosperity for political, economic and cultural development. There was a great demand for wood used as construction material and fuel, thus areas of forest was destroyed. After the Song dynasty, agriculture expanded significantly northward on the Loess Plateau, while the nomads retreated, thus the landuse and land cover were changed markedly. Due to the destruction of forest by man and, to a less[er] degree, due to the climate change from wet to dry, the southern boundary of steppe shifted southward greatly.

The impact of deforestation and clearance for agriculture that Jiongxin refers to as having a great impact upon bank-breeches is also supported by Xu (2003). Below Xu (2003: 3368) illustrates the correlation between the northward limit of the agricultural zone and the sedimentation rate. Notice the sharp increase in agricultural lands as the boundary pushed northward by almost 200 km in the tenth century, which is then maintained until the early to mid- twelfth century before a more gradual retreat southward begins.

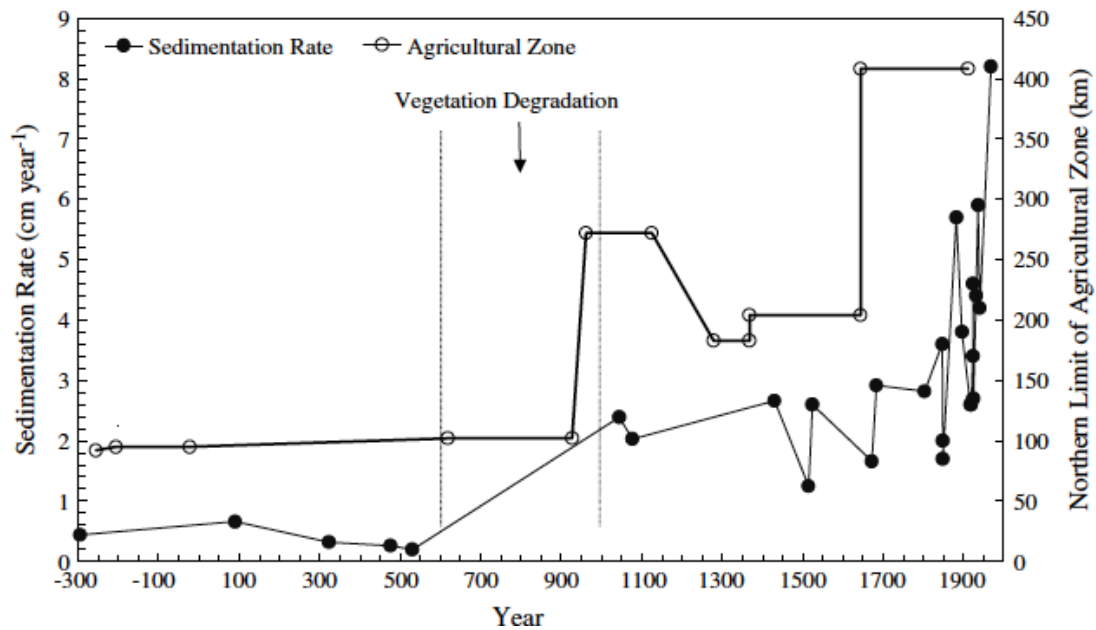


Fig.3.7. Temporal variation in the location of the agriculture- animal husbandry boundary on the Loess Plateau (Xu, 2003:3368).

Xu diagnoses the seventh to the tenth century as the period of a fundamental shift with a vegetation degradation that never regenerates to its past form. This is also period with the greatest sediment rate increase before the nineteenth century. From the early tenth century we see the agricultural zone shift almost 200 km northward and maintained that position until the late twelfth century, when it decreases until the late thirteenth century, from which point it remains relatively constant until the late seventeenth century. However, even with the variation of the northern boundary of agriculture (v. animal husbandry), the sedimentation rate remains relatively constant from the early tenth century to the late fourteenth.

Jiongxin (2001: 12) also observes that bank breaching events generally increase as populations increase and density, but this is not necessarily the case, as people moving to mountain and hill areas for agricultural cultivation and animal husbandry will greatly increase the risk of soil erosion and flooding even if area population numbers are not increased. This may play a role in the North China and the northeast Tibetan Plateau region as the Jin had fortifications in the mountains during the twelfth and early thirteenth century, (Atwood 2004: 276-277) as well as later as a place of refuge during periods of instability. Petach

(1988: 372) noted this took place in 1260, when Song troops attacked Tiao-men and the settlers to refuge in the mountains (Pelech, 1988: 369-380).

3.10 Mongol Expansion Following the Expansion of Grasslands and Greater Precipitation?

The Mongols were highly dependent upon their horses for their cavalry and transportation of goods, as well as their other animals for food and skins, especially as they expanded their territory (as dependency upon agriculture would have been less feasible). Therefore, the Mongols needed to have sufficient grazing lands for their herds in order to proceed with their expansion. Pederson *et al.* presented a 1,112 year tree-ring reconstruction of wetness during the growing seasons of the Siberian pine in central Mongolia. They found a fifteen year period, from 1211 to 1225 A.D. with above-average moisture, the longest on the dendrochronological record, which also coincided with the rise of Chinggis Khan (Pederson *et al.*, 2014:4375). Pederson *et al.* illustrate this wet period below that followed an especially dry period in the late twelfth century.

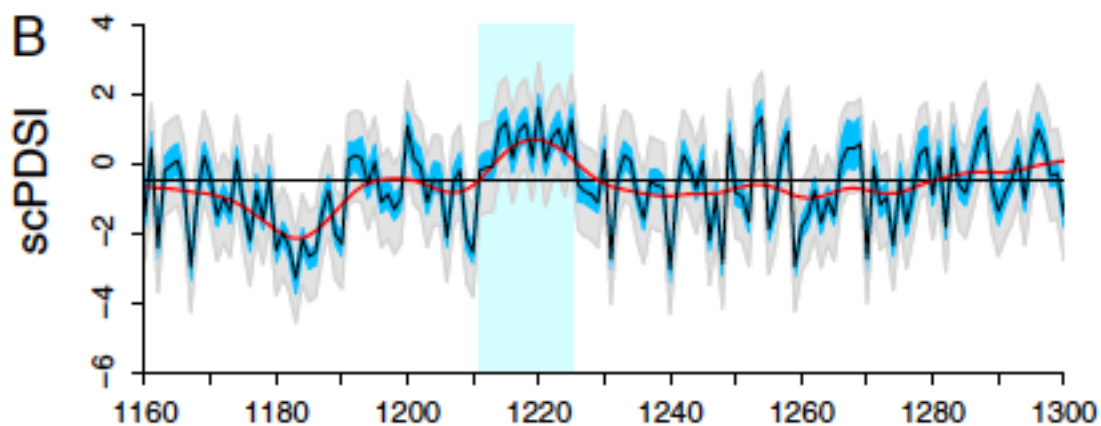


Fig.3.8. Moisture Balance in Central Mongolia. Pederson *et al.* (2014:4377) illustrate the moisture balance highlights include the extended 15-y Mongol Pluvial (1211–1225 CE; blue box) (Zhao, 2010:66-67) using Palmer Drought Severity Index (scPDSI), (Van der *et al.*, 2013: 4025–4048) a measure of aggregate water balance, derived from 107 living and dead Siberian pine (*Pinus sibirica*) trees growing on a Holocene lava flow in central Mongolia.

This above average wetness went well beyond Mongolia, however, with substantial regional variations. Zhao *et al.* observed especially high

Artemisia/Chenopodiaceae ratio at Hurleg Lake in the Northeast of the Tibetan Plateau at certain periods, as 1230 to 1320A.D. (Zhao, 2010:66-67). *Artemisia* requires substantially more water than Chenopodiaceae and this A/C ratio is often used as an indicator of relative wetness or dryness in semi-arid regions such as the Tibetan Plateau where both of these species thrive. However, these A/C ratios from Hurleg Lake are “show a generally negative correlation with pollen concentration from Dundee icecap, about 150 km northwest of Hurleg Lake...” Zhao *et al.* continue that a “high A/C ratio at Hurleg correlates with low pollen concentration at Dundee ice core” (Zhao, 2010:66-67).

Grießinger *et al.*, used tree-ring records to reconstruct relative humidity in the last 1500 years in the southeastern Tibetan Plateau. They stated that “more humid conditions prevailed during the period 850-1350”, however this period is interrupted from 1210 to 1260A.D. (Grießinger *et al.*, 2016:4) Wernicke *et al.* did a study a year earlier (2015) with tree-ring data over an 800 year period in the eastern Tibetan Plateau that registered the highest relative humidity of the 800 year study to be in 1272A.D., with general humid period being between 1193 to 1300A.D., which is followed by a dryer period from 1300 to 1345A.D. The peak year in 1272A.D. is interesting as this crest of wetness, as 1211 to 1225A.D. period in central Mongolia, are the highest points of wetness noted in the tree-rings in both the eastern Tibetan Plateau and central Mongolia, of 1,112 and 800 year dendrochronological records, respectively. Is the expansion of the Mongol Empire in these areas during these periods just a coincidence?

3.11 Environmental & Movement/Activity Changes in the Eastern Region of the Tibetan Plateau-

The Eastern Region had even more pronounced wetness, with a general period of greater humidity from 1193-1300A.D., with the peak in the over 800 year dendrochronological record in 1272A.D. (Wernicke, *et al.*, 2015:332)

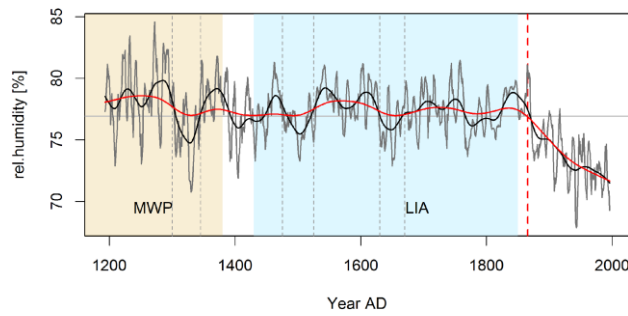


Fig.3.9. Summer (July + August) relative humidity reconstruction AD1193–1996 for the eastern TP. Solid black and red lines represent 50-year and 150-year smoothing splines, respectively. Red dashed line emphasizes the turning point towards drier conditions (←1870s). The horizontal gray line illustrates mean relative summer humidity (RH = 72.4 %). Vertical dashed lines mark relatively dry periods. The Medieval Warm Period (MWP) and Little Ice Age (LIA) are emphasized in yellow and blue (Wernicke, et al, 2015:332).

As the graph indicates there seems to be a short relative dry period a bit before the large spike in humidity in 1272A.D., which may line up with the Grießinger *et al.* study of the southeastern area of the plateau that indicated a dry period in 1210 to 1260A.D. Yet, the Wernicke *et al.* study of the eastern area of the plateau seems shorter and a bit wetter than what Grießinger *et al.* study of the southeastern area of the plateau indicate.

Zang *et al.*'s summary charts of multi-proxy records from Sugan Lake of northeastern Tibetan Plateau may be especially informative of these changes starting around the late twelfth/early thirteenth century.

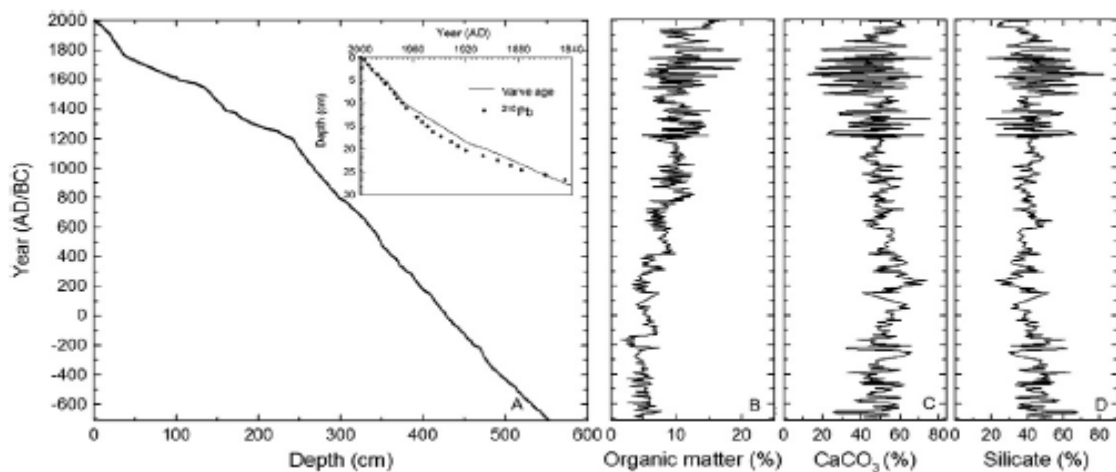


Fig.3.10. Chronology and lithology of core SG03I at Sugan Lake, northeastern Tibetan Plateau. A. Age–depth model based on varve counting; Inset figure shows the comparison of ^{210}Pb dating and varve counting results for the recent 150 years (Zhou et al., 2007). B. Organic matter (%); C. Calcium carbonate (%); D. Silicate (%) (Zhang et al

2010:293).

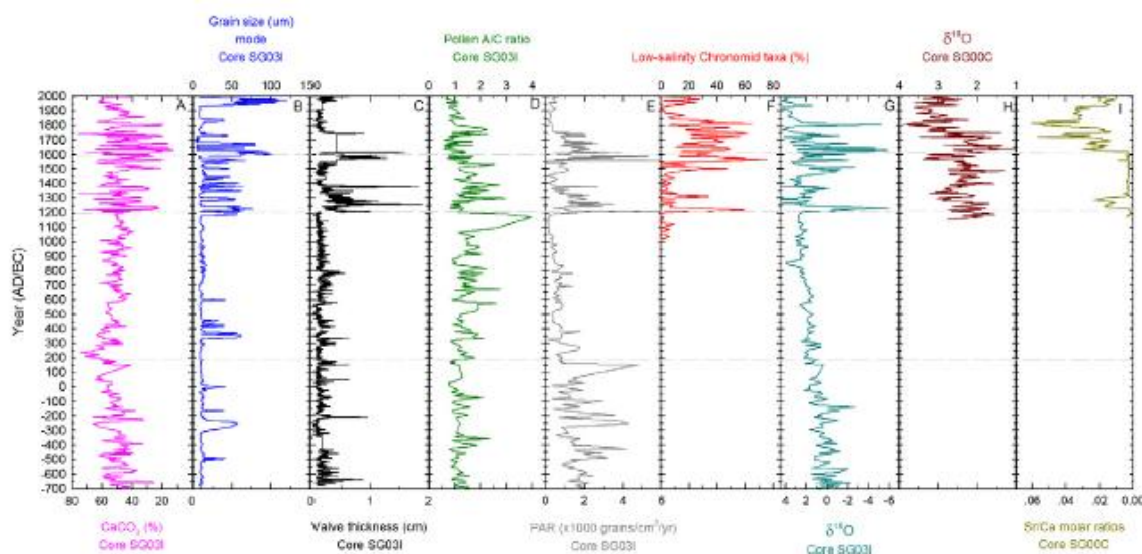


Fig. 3.11. Summary of multi-proxy records from Sugan Lake, northeastern Tibetan Plateau. A. Carbonate percentage based on LOI analysis from core SG03I; B. Grain size mode from core SG03I; C. Valve thickness (cm) from core SG03I; D. Pollen A/C ratio from core SG03I. E. Pollen accumulation rate (PAR, grains/cm² /yr) from core SG03I; F. Percentage of low-salinity Chironomid taxa from core SG03I (Chen et al., 2009); G. Oxygen isotopes of precipitated carbonates from core SG03I; H. Oxygen isotopes of ostracode shells from core SG00C; I. Mg/ Ca ratios in ostracode shells from core SG00C (Zhang et al 2010:293).

The dramatic volatility starting c. 1200A.D. is quite striking. Zang *et al.* indicate that this volatility is a significant sign of an unstable climate. However, they also note that “At 1250-1400A.D..., the A/C ratios have generally higher values, suggesting a relatively moister climate and a more steppe-like vegetation” (Zhang et al 2010:295) There is also an especially wet period shown in another area of the Mongol expansion, which would later be part of the realm of the Golden Horde, the Kazakh and Russian Steppes. Alekseeva *et al.* below illustrate the relatively wet period around the thirteenth-fourteenth century on five sites, Avilov (Volgograd region), Abganerovo (Volgograd region), Perefruznoe (Volgograd region), Kalmykia (Zunda-Tolga, Mandzhikiny, Iki Burul district, Republic of Kalmykia), and Malyaevka (Volgograd region)

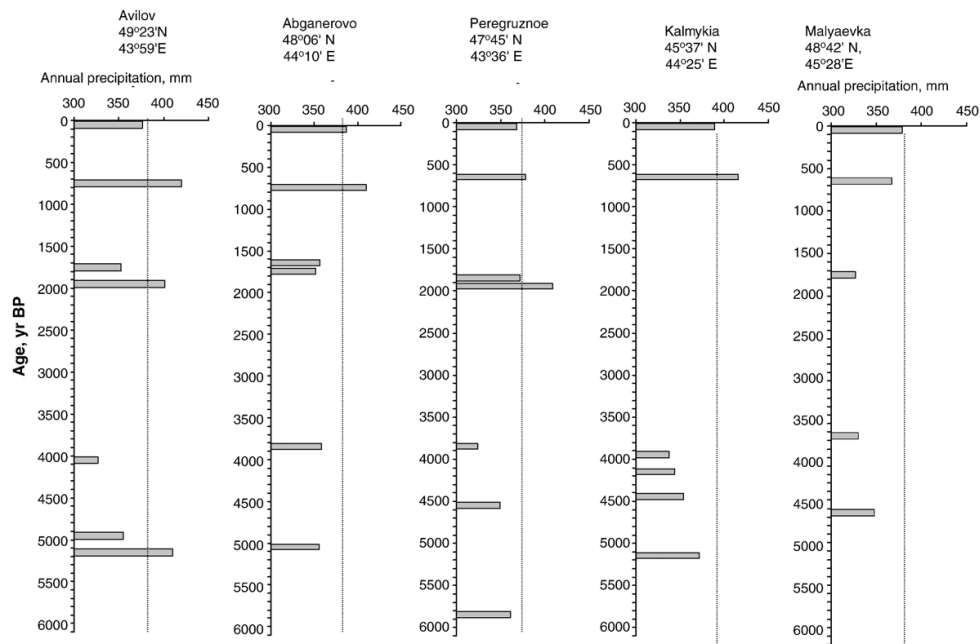


Fig.3.12. Precipitation rates found at the Kazakh and the Russian Steppes. Rainfall reconstructions of sites of the Russian and Kazakh Steppes based on present-day precipitation totals for each available palaeosol-derived timestep of these five sites, from c. 5000 B.P. onwards (Alekseeva et al., 2007:122).

These sites show an unusually wet period that was rarely seen in the last 5,000 years. Alekseeva *et al.* observed, “All but one of the Middle Ages (~ 600 yr BP) palaeosols record another interval of increased annual precipitation (+ 5 to +10%). For our easternmost site, precipitation levels have been consistently lower, but with precipitation maxima recorded at the Middle Ages and at the present day” (Alekseeva et al., 2007:125).

Pederson *et al.*’s proposal that the wetness of the period paved the way for the Mongol expansion by providing the more lush grasslands to feed their herds along the way. However, as noted earlier, some regions have dry periods at the same time that others are having wet periods. Can we call this part of a global phenomenon of high precipitation or is this a more regional occurrence? If regional climate change is a factor here, the wetness of the soil pre-dated the Mongol expansion but may have been impacted by human activity (as deforestation and herding). Dotterwich (2013: 27) interestingly observes the issue of floods and soil erosion from China to central Europe as being especially pronounced in the last thousand years in the Loess Plateau in China and during the late Middle Ages in central Europe, with a climax in the mid-fourteenth

century:

In China, the number of reports of floods increased for the Chinese Loess Plateau during the last 1000 years. This correlates with accelerated soil erosion and gullying as indicated by geomorphic evidence. The first observations on floods and related soil erosion events in central Europe date to the late Middle Ages. Particularly the extreme precipitation events and their associated floods in the mid-fourteenth century are well documented in different sources and correspond well with the geomorphic evidence (Dotterweich, 2013: 27).

The question here is if the risk of flooding and soil erosion was precipitated by human activity or it was just strictly a natural phenomenon.

V. Wetness, increased herding densities, and erosion of grasslands

3.12 Why increased wetness may be an important factor for a zoonotic epidemic?

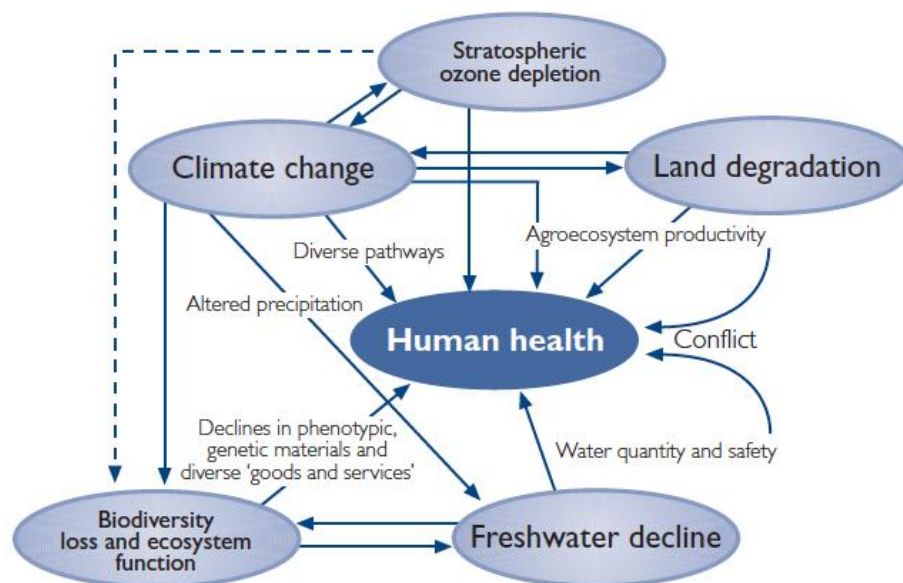


Fig. 3.13. McMichael's (2003:8) Diagram of interconnected relationships between major types of environmental change, including climate change.

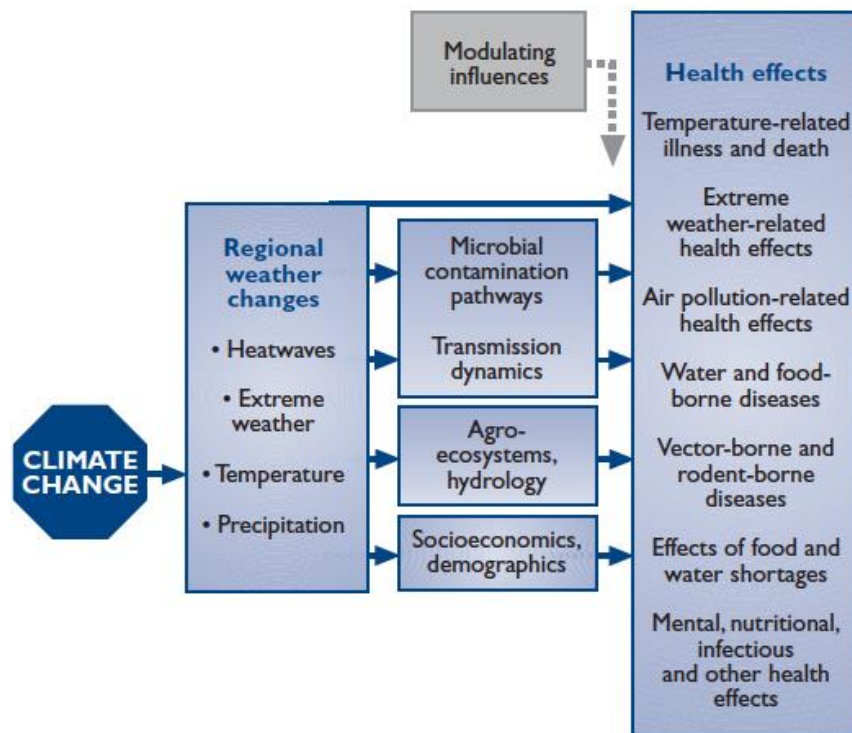


Fig.3.14. McMichael's (2003:10) diagram of "pathways by which climate change may affect human health, including local modulating influences and the feedback influence of adaptation measures."

Temperature and precipitation play an important role in what type of plant and animal life, as well as micro-biotic life survive and thrive in a particular geographic area. McMichael illustrates in the two diagrams above how precipitation and temperature changes the dynamics that ecosystems operate within, leading to different niches that lead to changes in biodiversity. These quickly developing niches that develop from dramatic changes in temperature or precipitation gives greater opportunities to species that are more generalists (regarding food intake), while many other species that rely on more specific niches will disappear. Thus, a population boom may come about in more generalist species, as some rodent communities that may be an ideal reservoir host for pathogens as *Y.pestis*. Thus, temperature and precipitation are important factors to consider in the spreading of such pathogens. However, when assessing these two environmental factors we must also be aware that global climate change is, by definition, a generality. It is always problematic methodology when an investigation extrapolates from the general to the specific.

Additionally, how a generalist phenomenon such as global warming comes about is a combination of known and unknown variables, that includes carbon emissions, diminished biomass of vegetation in the biosphere, and sea surface temperature. When measuring climate change in the Middle Ages we are certainly more limited than the present in obtaining detailed information of different regions. The degree that different regions contribute to the global climate change is up for debate and how much ecological changes in different regions result in regional climate change are also debatable. However, what should not be debated is that both global and regional climate (as well as local and microclimate) change play a role. No region can be considered absolutely isolated from the next, while more local phenomena as dense urban areas being warmer during the summer or areas by large bodies of water generally have more precipitation than those that are not.

Historian B.M.Campbell illustrates this controversy, as of a number of historians who refer to a medieval global cooling period, known as the Little Ice Age. This dramatic climate change is said to have underpinned the context for famine, a cattle epidemic, and the Plague. Campbell's main argument in *Physical shocks, biological hazards, and human impacts: the crisis of the fourteenth century revisited* is that the crops could not survive the 'physical shock' of the cold and subsequently neither could those that depended upon them. Campbell presents evidence of expanding ice caps, lowering sea temperature, and the diminished growing rate of trees while "the same period experienced worsening (cooling) environmental conditions on global and hemispherical scales" (Campbell 2010) around selected locations around the planet. He suggests,

... that the human impacts of the Great European Famine of 1315-21 and the Black Death of 1347-53 owed more to the unprecedented scale and extraordinary nature of the natural forcing agents than to the straitened economic circumstances of the day. Both were major and complex events with global environmental dimensions (Campbell 2010:31).

Campbell here proposes that the Great European Famine of 1315-21 and Black Death were largely the results of global climate change that set these events in motion and were just part of climatic impacts that effected environments around the globe. However, as Neukom *et al* (2014) illustrate below, there was no global

cooling or Little Ice Age in the fourteenth century, some cooling was only seen in the Northern Hemisphere.

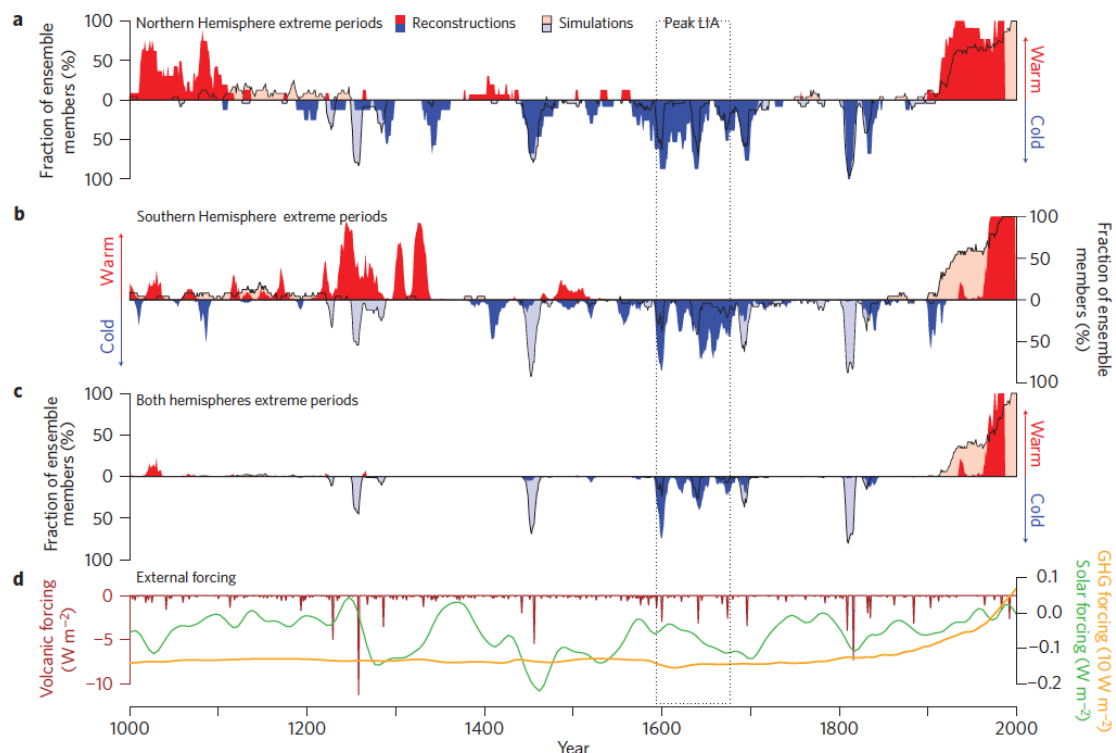


Fig.3.15. Neukom *et al* on this chart illustrates extreme warm (red) or cold (blue) decadal temperatures in the a) Northern Hemisphere, b) Southern Hemisphere, and c) indicating “probabilities for simultaneous extreme periods in both hemispheres...calculated by multiplying the fractions in a) and b). (Neukom *et al* 2014:365).

Can we generalise climate on a global scale and then accurately represent that change on the local and region levels? Additionally, can we say that people’s vulnerability to changes in climate can be held as a constant, regardless of actions and adaptations they may take that effect the ecosystems they depend upon and their exposure to pathogens?

3.13 Assessing Precipitation and Temperature during the Mongol Empire

During the last decade or so, there has been a great increase of research noting the connection between vegetation cover change over a landscape and regional climate change. Land cover change (LCC) has been the subject of more research and to many researchers, played a larger role than global sea temperatures. Findell *et al.* explain,

There is no doubt that large-scale land cover change strongly affects the regional climate over the areas subject to land clearance. Model experiments conducted using global climate models and regional climate models confirm this (Chase et al. 1999; Wang et al. 2003; Hahmann and Dickinson 1997; Heck et al. 2001; Narisma and Pitman 2003, Findell *et al.* 2009)

The effects of land cover change on a particular region can be such a degree that it can alter the global climate averages even when the effects of regional changes on climate are not felt beyond the LCC areas. The impact of LCC on regional water and energy cycles can be very significant and can lead to waterlogged soil and the leaching of soil nutrients. Findell *et al.* (2009) further illustrate the effect of regional LCC that particularly impacts agricultural fields,

In the regions where the land surface is altered, the impact of LCC can be equally or more important than the SST (Sea Surface Temperature) forcing patterns in determining the seasonal cycle of the surface water and energy balance. Indeed, in many regions, the land cover change experiment had the greatest impact on surface fields such as runoff and soil moisture. In some regions, these fields were significantly affected even when the regional climate was not. Thus, we provide a context for the impacts of LCC on climate: namely, strong regional-scale impacts that can significantly change globally averaged fields but that rarely propagate beyond the disturbed regions. (Findell *et al.* 2009:3266-3267)

If these regional differences in climatic change are the norm, (Findell *et al.* 2009, Li *et al.* 2015, Legates *et al.* 2011, Luyssaert *et al.* 2014, Mahmood) why do these regional climatic differences occur? The first point to highlight in LCC is that large-scale deforestation and clearance has been shown to significantly alter the region(s) where the decline in vegetation cover has taken place. These areas cleared of vegetation would be especially vulnerable to changes in temperature and precipitation, as there is a lack of vegetation and trees to protect the soil surface from water erosion as well as a lack of deep root systems that greatly contribute to water infiltration deep into the soil. This impact is seen in the rate of evapotranspiration, as Zang, Dawes and Walker illustrate in the graph below:

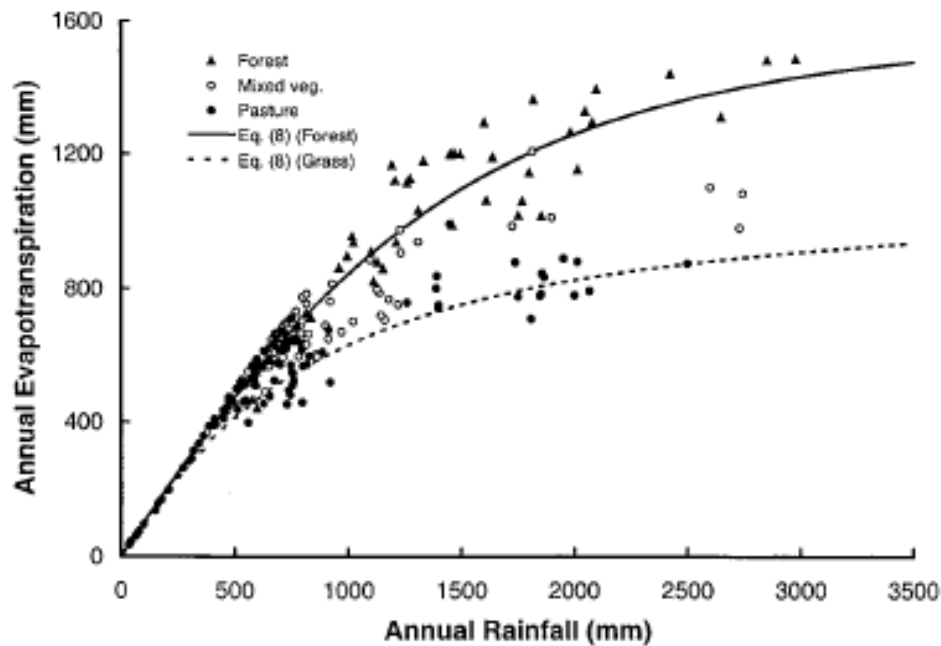


Fig.3.16. This graph illustrates the different evapotranspiration rate in forest, mixed vegetation, and pasture. The data based upon over 250 catchments worldwide, compiled and analysed by Zhang, Dawes, and Walker (2001:707)

Zang, Dawes and Walker above illustrate the substantial difference between a forest environment, mixed vegetation, and a pastoral area. The graph above illustrates the general tendency for greater vegetation densities being associated with greater evapotranspiration rates. These differences start around 300mm of rainwater a year and grow from that point. Areas of low rainfall that support forests have a relatively low evapotranspiration rate, as plant-life attempts to secure more water for their own survival, whereas areas of lower vegetation densities do not have such a tendency. Zang, Dawes, and Walker demonstrate this phenomenon in the graphs below:

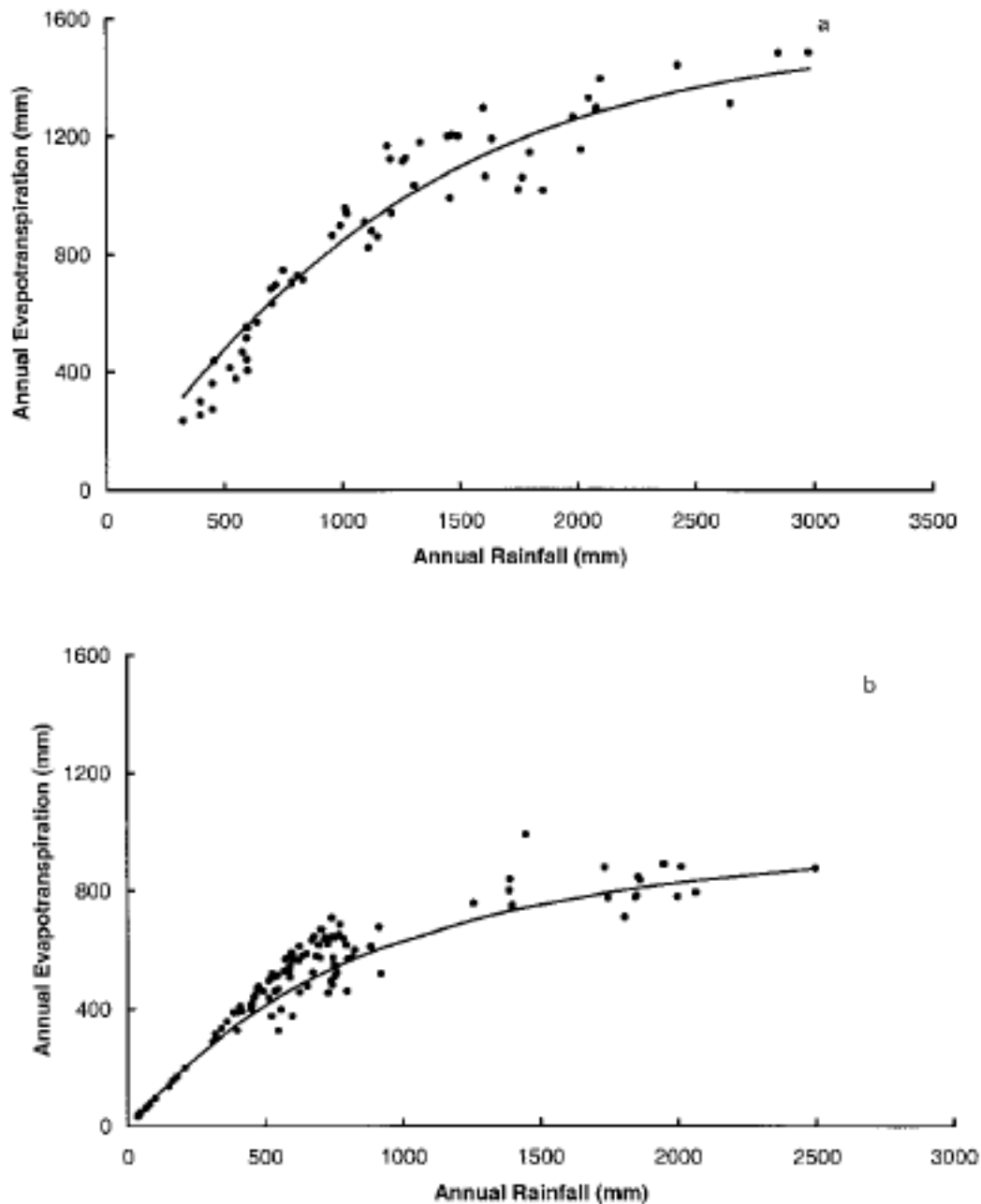


Fig. 3.17a & 3.17b. Scatterplot Graph of Annual Evapotranspiration and Rainfall of Forest and Herbaceous Plant Catchments. The average evapotranspiration from over 250 catchments worldwide was estimated for (a) forested and (b) herbaceous plant catchments from average annual rainfall, which was obtained by a least squares fit based on the data listed by Zhang et al. [1999]

The top graph of a forested environment with approximately 300-700mm of rainfall a year shows a significantly less evapotranspiration rate than seen elsewhere on the graph. Trees require a very significant amount of water to survive, which has been illustrated in recent studies in China of tree plantations

in semi-arid lands (See Chen *et al.* 2007:397). This is relevant in assessing ecological changes in the Mongol Empire, which needed surplus food and wealth to continue this expansion. This expansion required more lands be deforested and cleared for agriculture and pastoral lands, which has been seen in central Mongolia, as noted before, but also in lands they expanded into, as the Tibetan Plateau. The best grazing lands of the Tibetan Plateau are the frigid swampy meadows that provide an environment for lush grasslands, but these grasslands also are vulnerable to overgrazing that leads to lower biomasses and greater evapotranspiration rates. Gao and Li (2016) illustrate this in the two photographs below of the frigid swamp meadows, the first one in a healthy state and the other severely degraded.

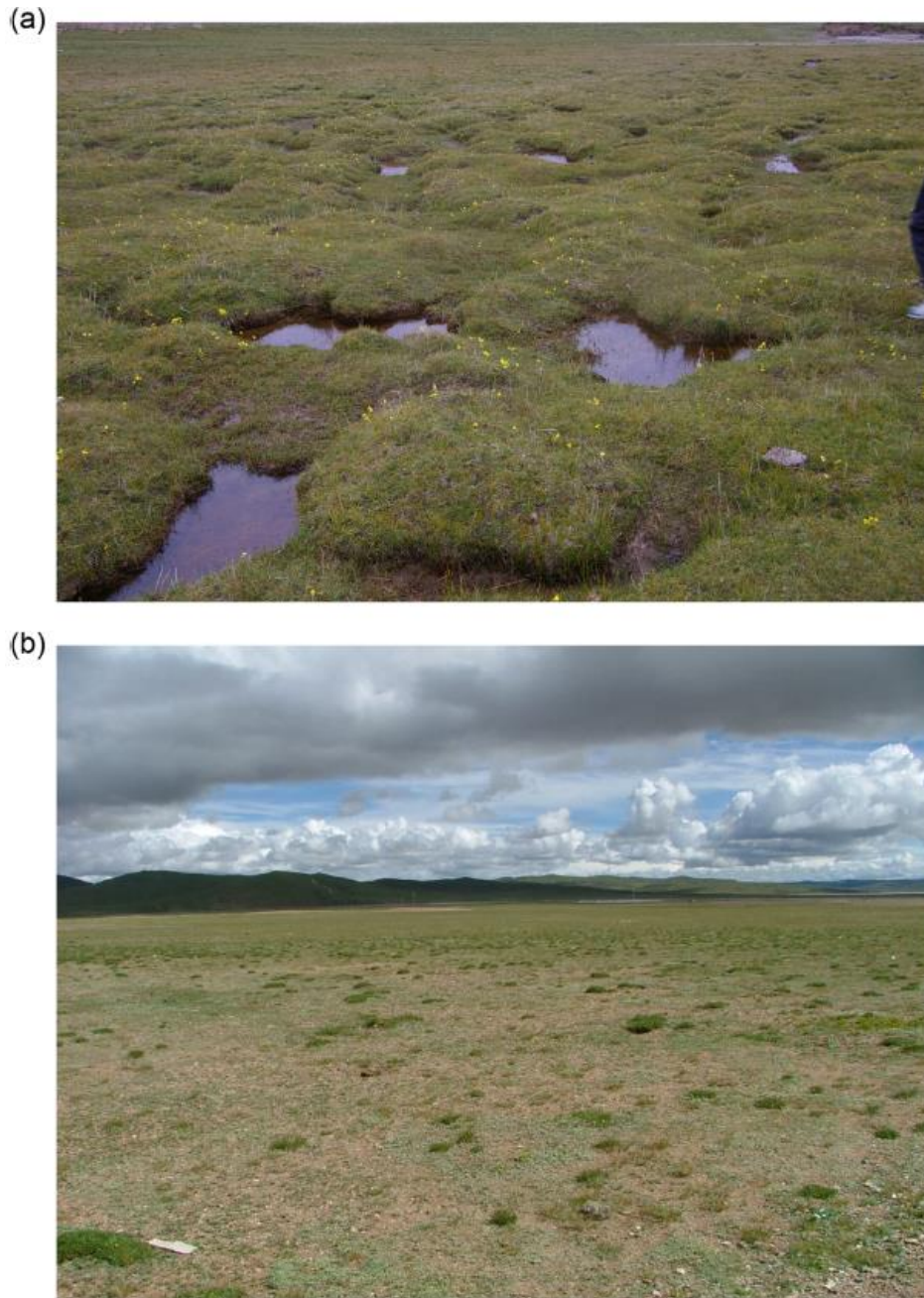


Fig.3.18a & 3.18b. (a) Is a healthy frigid swampy meadow at the foot of a mountain in the Tibetan Plateau that consists of water-filled shallow depressions and hardy mounds of an uneven surface. (b) Is as severely degraded frigid swampy meadow (also known as a *heitutan*) further away from the mountains where most of the original turf and sod has been destroyed by overgrazing and rodents with secondary regenerating weeds and coarse gravel and sands remaining (Gao,2016:796).

The changes of the frigid swampy meadow is dramatic as the first picture shows that the landscape changes from one of lush grasses with depressions filled with water to a much drier and flat surface with little vegetation. Gao and Li chart the

stages of this degradation of the meadow to the severely degraded *heitutan* level below:

Table 3.2. Gao and Li chart (2016:803) highlights geological differences among surfaces of different levels of soil moisture : a swamp meadow, dried grassland, degraded meadow, and a *heitutan*.

Stage	1. Swampy meadow	2. Dried grassland	3. Degraded meadow	4. <i>Heitutan</i>
Surface morphology	Isolated dents	Isolated dents	Isolated mounds	Flat without relief
Surface hydrology	Pond of water	Wet surface	Moist surface	Dry surface
Moisture (% at 10 cm deep)	>50	>40	>=25	<25
Vegetative cover (%)	>90	>80	>=50	<50
Soil structure	Dense, hardy turf	Hardy turf intact	Loose soil with isolated turf	Loose sand without turf
Soil organic matter (g.kg ⁻¹)	>16	15–16	11–15	<11
Soil texture	Fine silt and clay	Silt and clay	Sand	Sand and gravel

The increased dryness, the flattening of the landscape surface, decreased vegetation cover, diminished soil structure and cohesiveness as well as organic matter in the soil illustrates the dramatic changes that transformed this environment. It is important to note that global or hemispheric climate change are not considered major contributors to this dramatically altered landscape, rather overgrazing and burrowing rodents are. Notice in the graph below that the degree of grazing is tied to how quickly or slowly an area degrades:

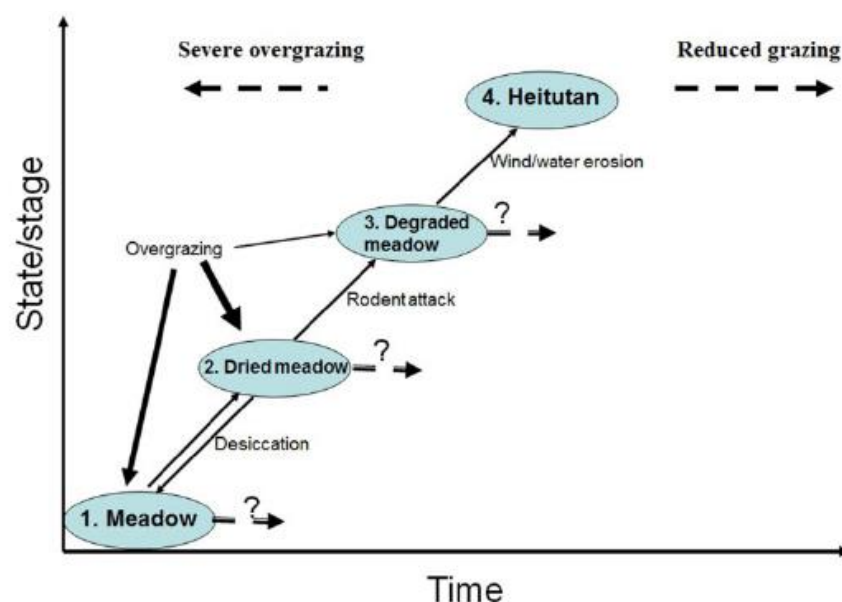


Fig. 3.19. Gao and Li (2016:804) illustrate the major stages of frigid swampy meadow degradation and the chief factor(s) from one state to the next with time.

This transformation of the meadow begins with the grazing of livestock that create a more amiable environment for burrowing rodents. The burrowing rodents then further consume the grasses and create large burrow structures that expose more moisture to the air and diminish the vegetation cover of the soil, thereby increasing the evapotranspiration rate. This process brings about a drying out of the soil and results in a large increase of loose soil, which is especially vulnerable to wind and water erosion. This process of degradation of the frigid swampy meadows is modelled below:

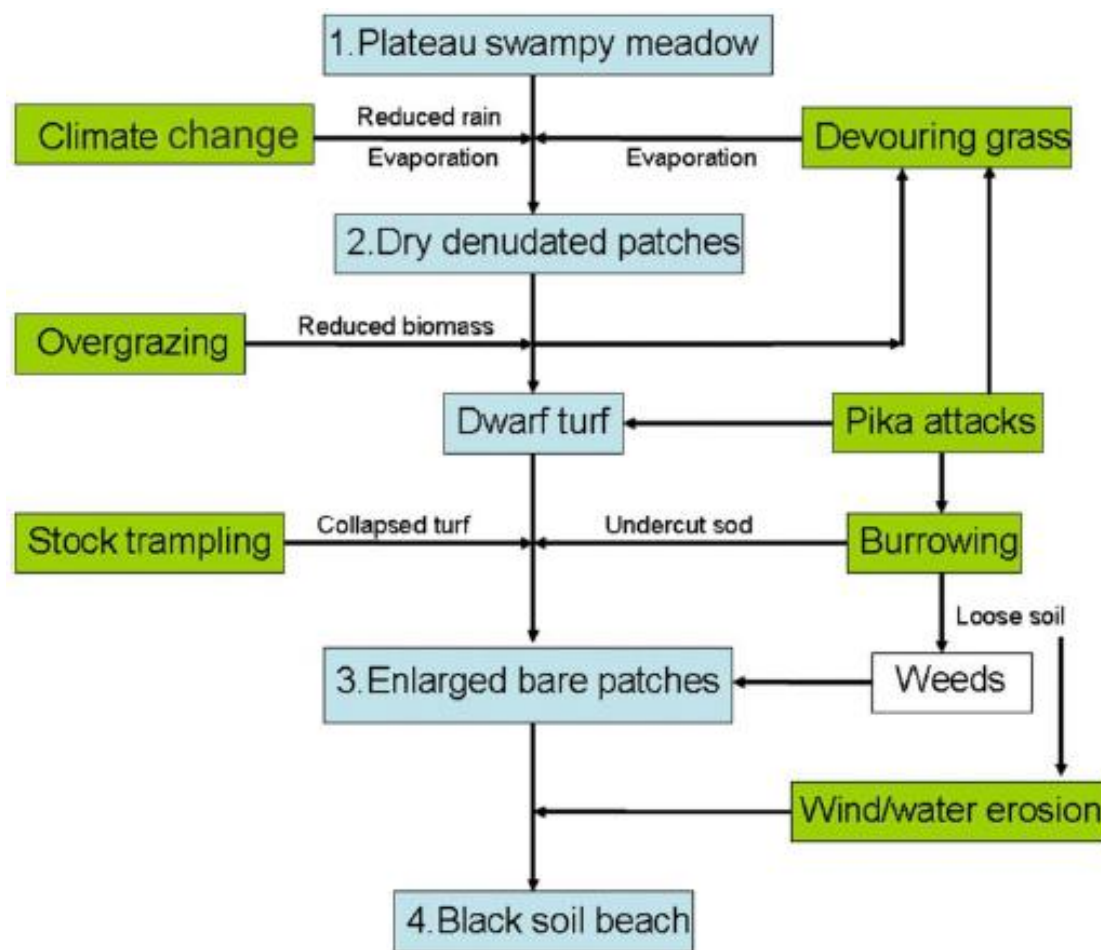


Fig.3.20. Gao and Li's model (2016:803) of the process of degradation of the frigid swampy meadow with four major stages: 1) Healthy swamp meadow, 2) Dry meadow, 3) Degraded meadow (wasteland), and 4) *heitutan* (badlands)

Gao and Li demonstrate the impact of various factors that lead to the degradation of the frigid swampy meadow that is largely tied to livestock grazing and burrowing rodents' impact on the vegetation and soil. The impact that livestock and the burrowing rodents also affect the temperature of the soil as it

becomes increasingly exposed and compacted. Additionally, Cao *et al.* observed that a sample high grazing site on the Tibetan Plateau had higher mean air and soil temperatures significantly greater than the low grazing site. They explained, “The higher air temperature [which was measured 5 cm above the ground] in the HG [high grazing] site...seems due to the less vegetation and lower soil moisture, which both tend to increase surface albedo and the air temperature close to ground surface” (Cao et al.,2004:239). The relationship between soil respiration and soil temperature is shown in the graphs below:

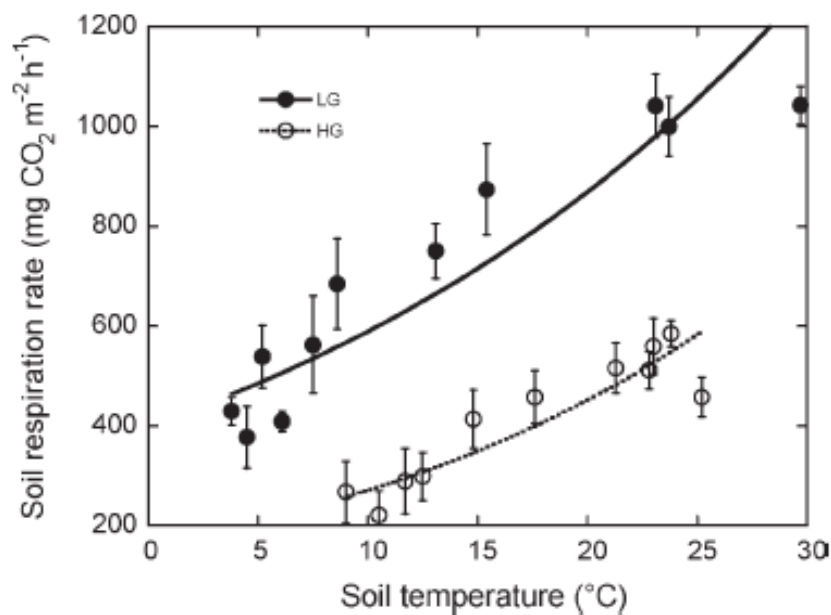


Fig.3.21. Measured diurnal soil CO₂ flux vs. soil temperature. The equations for the predicted model are soil CO₂ flux $\hat{y} = 420 \exp(0.039 \text{ soil temperature})$, $r^2 = 0.913$; $p < 0.001$ for the LG site and CO_2 flux $\hat{y} = 163 \exp(0.051 \text{ soil temperature})$, $r^2 = 0.897$; $p < 0.001$ for the HG site. Vertical bars indicate the standard error of the measurement mean $\pm 3\text{SE}$ for each time (Cao et al.,2004:240).

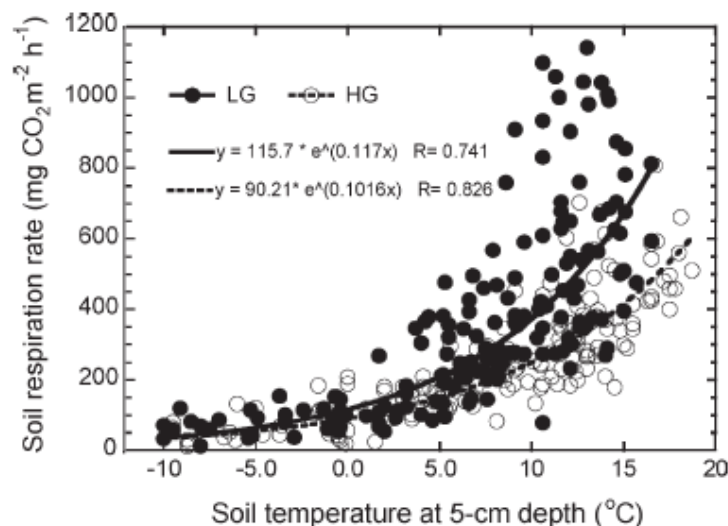


Fig. 3.22. Dependence of soil respiration on soil temperature measured during the period from May 1999 to April 2000. The equations for predicting soil respiration from soil temperature are $y = 115.7 \exp(117 \text{ }^\circ\text{C}^{-1} x)$, $r^2 = 0.826$ for the LG site and $y = 90.2 \exp(101 \text{ }^\circ\text{C}^{-1} x)$, $r^2 = 0.740$ for the HG site. $P < 0.001$ for all regression coefficients and intercepts (Cao et al.,2004:241).

Cao *et al.*'s models illustrate climate change taking place on a micro-level, but large herds have the potential to have a dramatic impact on the local landscape and the hydro-cycle in semi-arid areas affected by overgrazing. There may have indeed been greater precipitation taking place in the northern hemisphere during the thirteenth century, which may have given the Mongols an opportunity to expand their empire through the expansion of lush grasslands that their horses and livestock could take advantage of (Du et al.,2004:248).

Even with a modest precipitation, these frigid swampy marshes have been able to stay wetlands in semi-arid, northern or high altitude regions, as the Tibetan Plateau, since they stay cool or cold year round, and therefore, have a very limited evapotranspiration rate. However, as the Mongol herds grew larger and spread to new lands, as the Tibet Plateau, many of which were already supporting herding for the livestock of local peoples. Consequently, we must consider that as the impact of the grazing intensified, the burrowing rodent population increased, producing more burrows while vegetation decreased as well as the moisture in the soils.

3.14 Did the Mongol expansion lead to a decrease of vegetation biomass and soil erosion in its path?

As seen in Lehmkuhl *et al.*'s pollen diagram of Karakorum, Mongolia (See p.61), we saw a similar phenomenon taking place as seen in the previous example on the Tibetan Plateau with diminished wetness and lush grasses with indicators of increased grazing activity. The cereal pollen spiked sometime before the fourteenth century and may correspond with the archaeological evidence of cereals in the Mongol period (though may have been earlier during the Uighur presence) (Lehmkuhl et al. 2011:38), while the PAC-index showed increased wetness until it peaked around the end of the thirteenth century. Interestingly,

the climax of wetness at this time coincided with the disappearance of cereals, and the greatest presence of Poaceae, burnt plant particles [charcoal] and pollen grains in clumps (an indicator of some dehydration of the individual grains). While charcoal particles only decreased slightly around the mid-fourteenth century, wetness and pollen grains in clumps went down dramatically. The charcoal particles are an indicator of clearance of vegetation, while the clumping of pollen grains is evidence of a higher grazing pressure. Lehmkuhl *et al.* (2011) also note that “spores of plant parasitic fungi (Urocystis-, Thecaphora-type) and spores of coprophilous fungi (Sporormiella-, Sordaria-type)” (Lehmkuhl *et al.* 2011:38) are also evidence of an increase of grazing pressure.

3.15 The Expansion of Grazing Pressure on Semi-arid lands and the development of Dust Storms

Dust Storm Record on the Siberian Ice Core

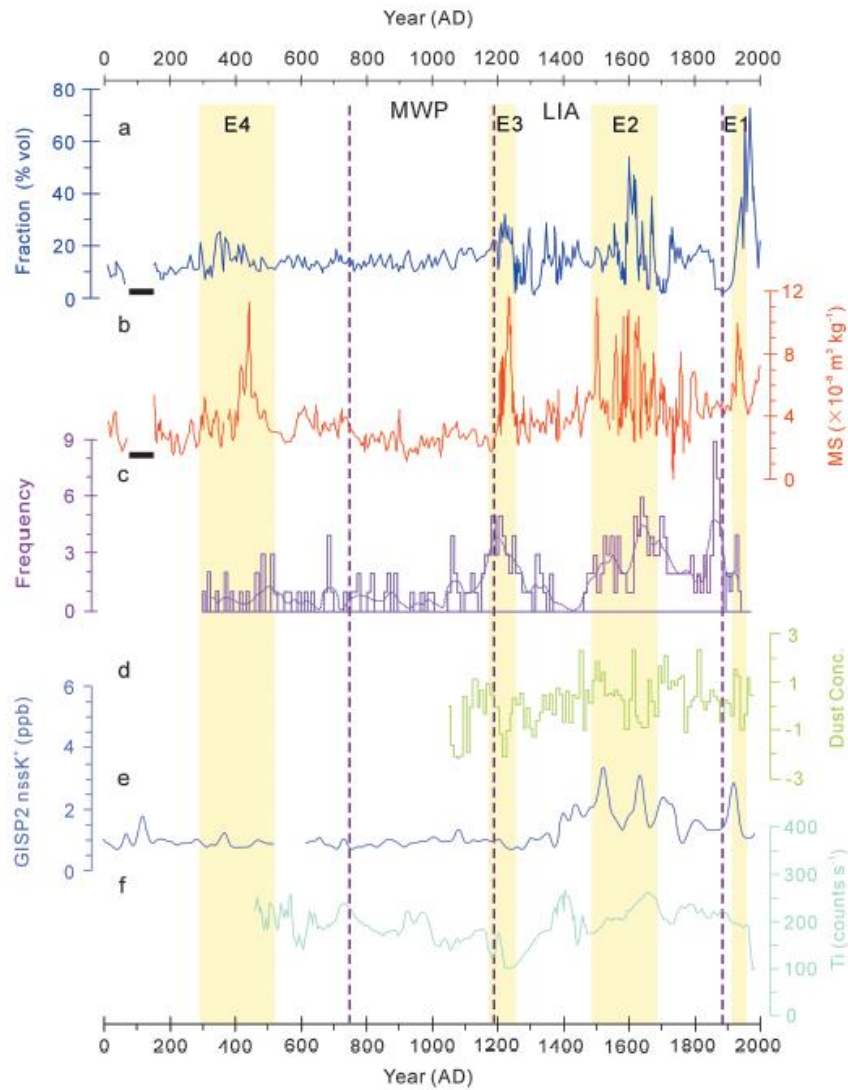


Fig.3.23. The nssK+ record that indicate non-sea salt ions on the Siberian Ice core, which is located in the northern Qinghai-Tibet Plateau (e) shows evidence for dust storms (E3) (Chen et al., 2013:2156)

Icelandic Low Proxy Record compared to the Siberian High Proxy Record

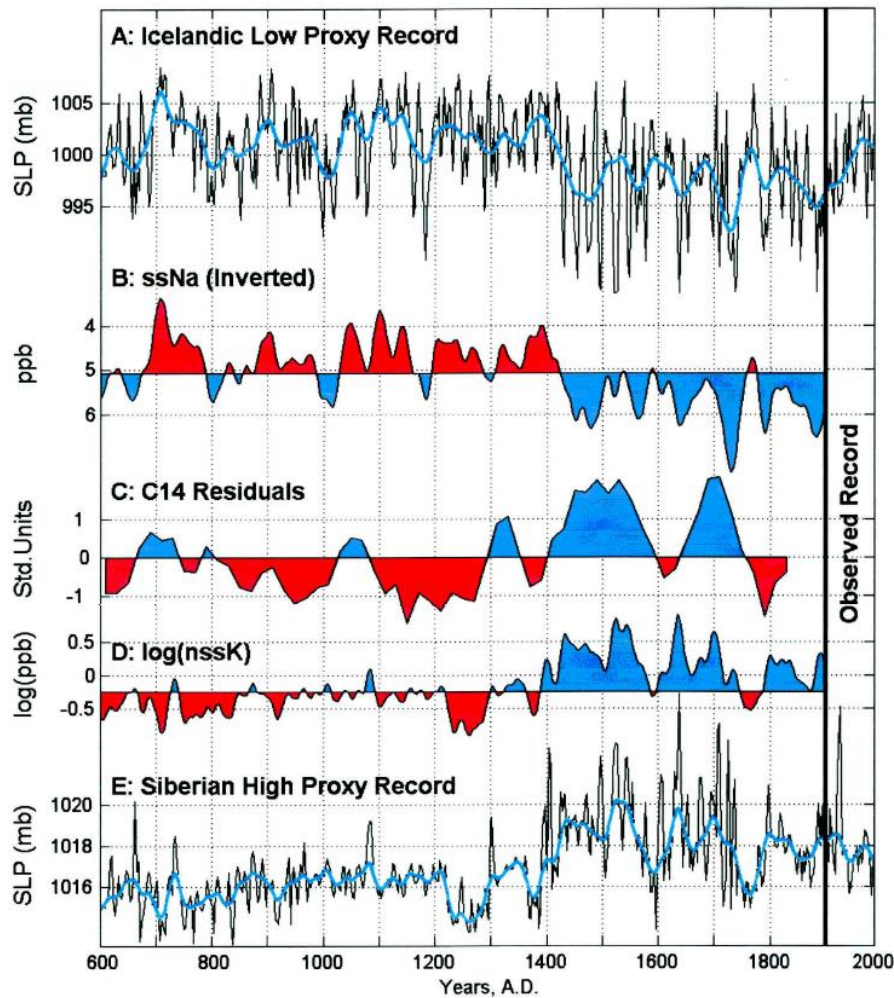


Fig.3.24. Notice the differences between the Siberian High Proxy Record (same record as previous chart, and the Icelandic ice core c.1200A.D., indicating what is being measured on the Siberian record is a regional phenomena (Meeker and Mayewski 2002: 261).

The impact of high grazing pressure on semi-arid regions has been of great interest in Mongolia and China in recent decades as dust storms have become more frequent and problematic. Munkhsetseg *et al.* explains this as a problem with a long history in observing, “Mongolian Grasslands is one of the natural dust source regions and it contributes to anthropogenic dust due to its long tradition of raising livestock”(Munkhtsetseg et al.,2017:1).The development of vulnerability for dust storms has been tied to heavy grazing that leads to land degradation through the decline of desirable plant species composition, low soil productivity and fertility and has been shown to be especially severe in areas close to urban settlements and water resources (Munkhtsetseg et al.,2017:2).

The decrease of vegetation height and lower vegetation cover leads to fewer wind barriers to protect the topsoil, while dense herds trampling the surface loosens up the soil. This increases wind erosion of the fine nitrogen, sulphur and organic carbon and other organic particles, leaving behind larger, coarse particles that are less able to support vegetation (Steffens et al.,2008: 69; Tong et al., 2004:134).

According to He *et al.* dust storms in northern China started to increase roughly around 1100A.D. (He et al.,2015:1) The graph below illustrates the dramatic change that seems to have taken place around the end of the twelfth century:

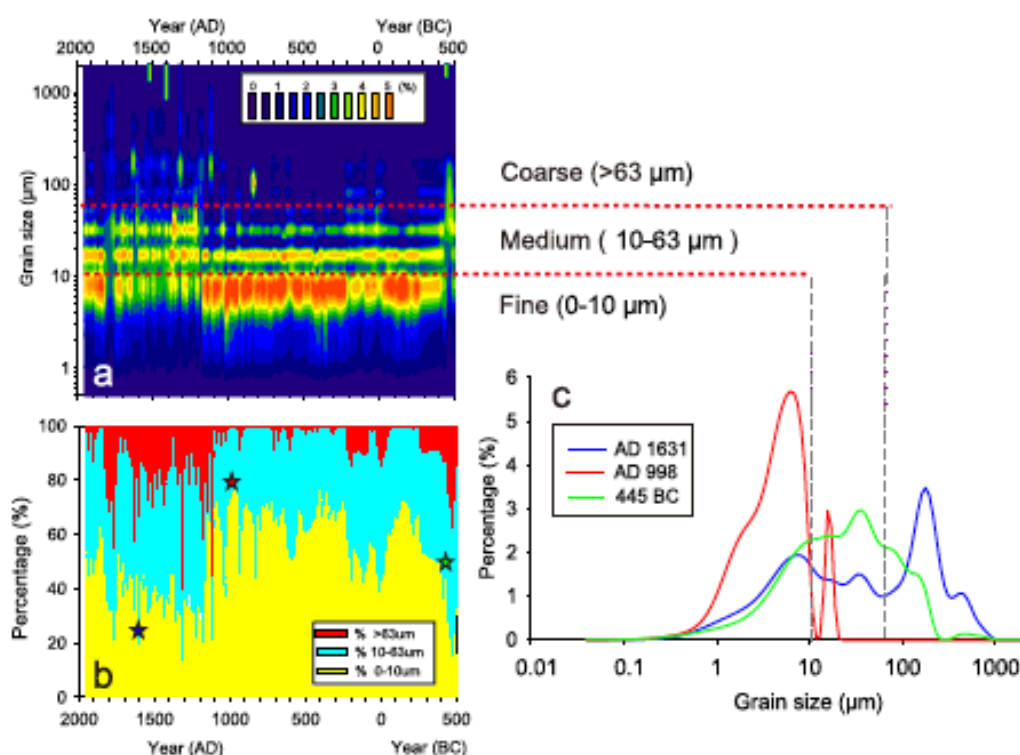


Fig.3.25. He *et al.* (2015:3) explains, “Grain size distribution in sediments from Lake Gahai over the last 2500 years. (a) Contour plot of grain size distribution. (b) Percentage of three major grain assemblages: fine (0–10 μm), medium (10–63 μm), and coarse (>63 μm) sub-populations. (c) Grain size distributions in three representative samples of Lake Gahai sediments, indicated by stars in (b).”

He *et al.* note that according to the historical records the “major peaked dust events occurred at episodes centered at ~AD 1200, 1600 and 1800...when relatively warm-dry conditions occurred in northwestern China” (He et al.,2015:3-4). He *et al.* uses carbon 14 dates (as applied with the pollen data in this paper), which should be used as an approximate estimate and is not as accurate or reliable as tree ring dates, but they

illustrate some fundamental change is taking place during this period. This evidence correlates with other information about dust storms and pollen evidence in Mongolia, Inner Mongolia and a bit later on the Tibetan Plateau.

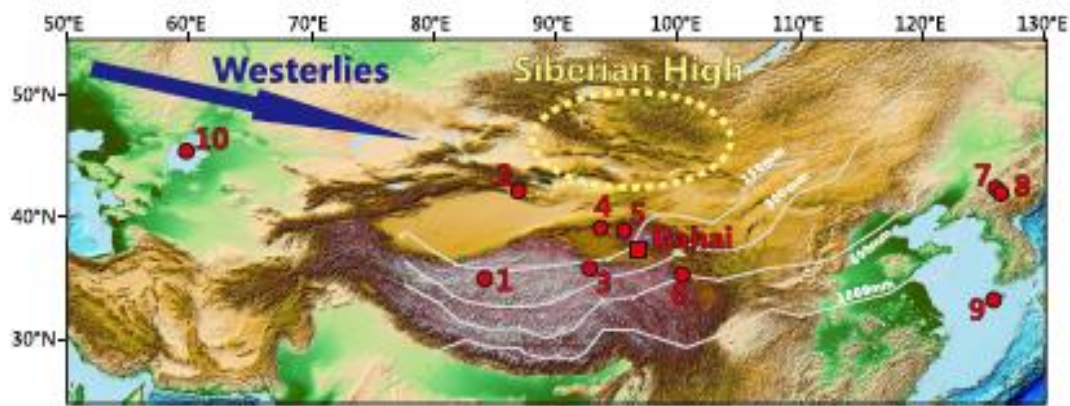


Fig.3.26. Dust storms from the 12th century.He *et al.* (2015) explains, “Overview map showing the study site, Lake Gahai (square) and sites of other dust records discussed here (circles). 1: Guliya ice core22; 2: Lake Bosten20; 3: Lake Kusai18; 4: Lake Sugan10; 5: Dunde ice core23; 6: Lake Gengga19; 7: Lake Sihailongwan16; 8: Lake Xiaolongwan16; 9: Cheju Island24; 10: Aral Sea21. The map was generated using ESRI ArcGIS v9.3 software with SRTM DEM database from Geospatial Data Cloud (<http://www.gscloud.cn>) shared by Computer Network Information Center, Chinese Academy of Sciences. Annual rainfall isohyets in China, Siberian High and westerlies are also indicated in the map” (He et al.,2015:2).

As noted earlier, wetness on the eastern Tibetan Plateau peaked around the mid-thirteenth century, whereas Wernicke *et al.* (2015) observed that AD1300-1345 was a period of especially low summer humidity (which is also seen on Wernicke *et al.*'s graph on p.50)(Wernicke et al, 2015:331). The pollen data from Sugan Basin of the northeastern Tibetan Plateau shows a dramatic change from a stable climate indicated from an A/C ratio of constantly low values from 300-1200A.D. to a very unstable climate around 1200A.D. that frequently varied from relatively moist climates to dry (Also see Zhang *et al.*'s graphs on p.51) Zhang *et al.* observes a generally moister climate with more steppe-like vegetation from 1250-1400A.D. (Zhang et al.,2010:295).

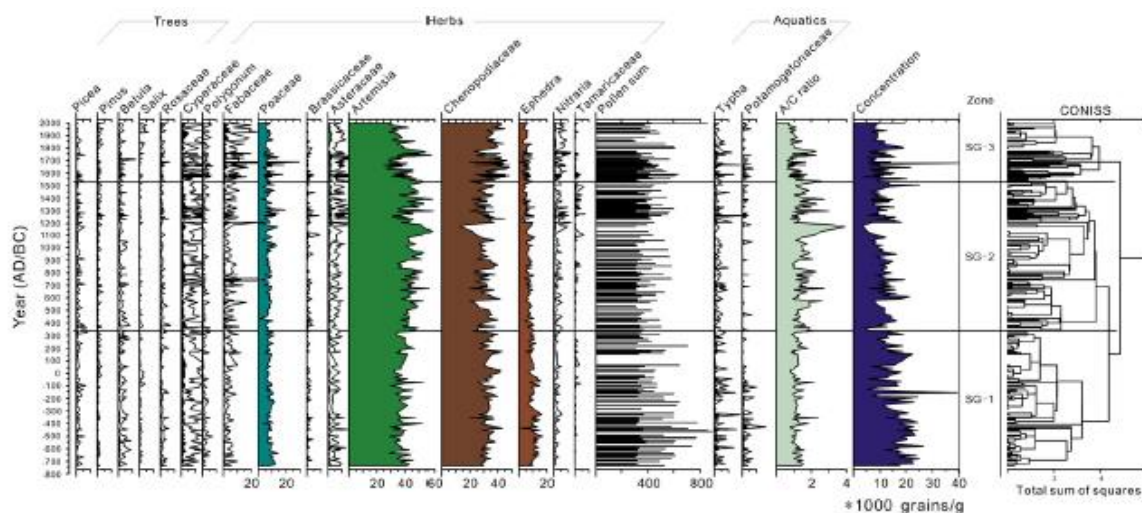


Fig.3.27. Pollen Diagram of Suga Lake, Northeastern Tibetan Plateau. Summary percentage pollen diagram of core SG03I at Suga Lake, northeastern Tibetan Plateau. Only selected taxa shown. Open curves for taxa with low abundance are 5× exaggerations (Zhang et al., 2010:295).

The low pollen concentration at Suga Lake shown in Zeng *et al.*'s pollen diagram around the late twelfth to the early thirteenth century may indeed be an indicator of dust storms that were also seen in northern China (which are seen on the map on the previous page). Whereas ephedra (which is often used to feed livestock) had a general increase during this time of low pollen concentration, but followed with a steep decline with significant volatility. The volatility of the presence of many herbs from around 1200A.D. onwards may be directly related to the movements of large herds.

The pollen concentration also started diminishing in the late twelfth century (and increased in the early fourteenth century), which is apparent at Hurley Lake of the Northeastern Tibetan Plateau. Additionally, the greatest presence of ephedra is in the early-mid fourteenth century; suggesting large-scale herding was not present there during this time. The decrease of Poaceae starts around the early to mid-thirteenth century while bottoming out when ephedra climaxes. The Artemisia/ Chenopodiaceae ratio is often used in arid environments to show shifts from humid to dry conditions, however, Artemisia, which does better during relatively humid weather, is on the increase leading to and during a dust storm on the pollen diagram. Chenopodiaceae, which survives better during drier weather, dramatically decreases while Artemisia increases, but the trend reverses, seemingly around the peak of the impact of the dust storms, and

possibly when conditions become dry. Cyperaceae, especially *Kobresia* is very frequently a very dominant grazing plant that livestock consume on the Tibetan Plateau. As the Food and Agriculture Organization of the U.N. stated, "Cyperaceae, especially *Kobresia* spp., dominate many of the better-watered, hard-grazed yak pastures, especially those of the alpine meadow type" (Food and Agriculture Organization of the United Nations. What are grasslands and rangelands? Grazing systems. <http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/scpi-home/managing-ecosystems/management-of-grasslands-and-rangelands/grasslands-what/en/>)

3.16 Why would Artemisia increase (as a pollen percentage) under heavy grazing pressure?

Artemisia spp. in semi-Arid/Arid central Asia are often grazing tolerant and are only eaten by livestock as a last resort. Miehe et al (2009: 138) explain that in the eastern Tibetan Plateau there are "no fewer than 40 species of *Artemisia* are present with representatives in nearly all treeless plant communities, prevailing in highly degraded pastures or wastelands..."(Miehe et al.,2009:138). This is also illustrated by Fujita and Narantsetsegiin. (2012: 25) illustrate this below in Mongolia:

Dominant species of grazing-tolerant plants according to vegetation zone

Forest steppe

Artemisia dracunculus

Iris lacteal

Urtica cannabina

Steppe

Artemisia adamsii

Achnatherum splendens

Dry steppe

Annuals

Artemisia pectinata

Peganum nigellastrum”

The abruptness seen in the *Artemisia* and *Chenopodiaceae* in the c.12th to early 13th century and *Cyperaceae* from c. the late 12th century is unusual for climate change, as Li et al (2013) explain, “Dissimilar to climate change-induced degradation, such anthropogenic degradation [as overgrazing] is a rather short-term process altering the abiotic properties of the underlying soil...” (Li et al., 2013:72) This vulnerability to overgrazing is especially high in the arid and semi-arid regions as the Tibetan Plateau, as Li et al continue,

Most of the rich rangeland resources in China are distributed in the environmentally fragile west and northwest and can be degraded easily under adverse conditions. Land degradation in such a setting is defined as the process of declining rangeland quality to such a level that surface vegetation has been fragmented as a result of excessive human activities and/ or unfavourable natural conditions (Li, 1997). Its manifestation includes initial lowering of rangeland productivity, fragmentation of grass cover, reduction in soil fertility, soil compaction, an increase in unpalatable grass species or a combination of all of them. In extremely degraded rangelands the underlying soil may be so denuded as to lead to desertification. Hence, rangeland degradation is detrimental to rangeland health and undermines animal husbandry. (Li et al., 2013:72)

Miehe *et al* (2009) and Schlütz and Lehmkuhl (2009) also interpreted pollen evidence for animal husbandry on the Tibetan Plateau in a similar manner for much more subtle for the beginnings of herding thousands of years ago. Rather, this period is focusing on a more modern and profound intensity that started during the 12th century and has generally continued to have greater herding intensity based upon the instability since the 12th century of *Cyperaceae*, *Poaceae*, and *Ephedra*, which are key livestock fodder. This is also seen in the summary charts of Zang *et al.* multi-proxy records from Sugan Lake of north-eastern Tibetan Plateau may be especially informative of these changes starting around the late twelfth/early thirteenth century. The basic reason overgrazing is evident in the pollen record is that, as Li et al (2013: 76) explains, “Overgrazing

diminishes soil nutrients, which in turn adversely affects rangeland biomass. Overgrazing over an extended period deprives the rangeland ecosystem the chance of recovery, and results ultimately in rangeland degradation”(Li et al.,2013:76). Evidence of heavy grazing and overgrazing continues on other sites moving westward, although not as pronounced as Sugan Lake.

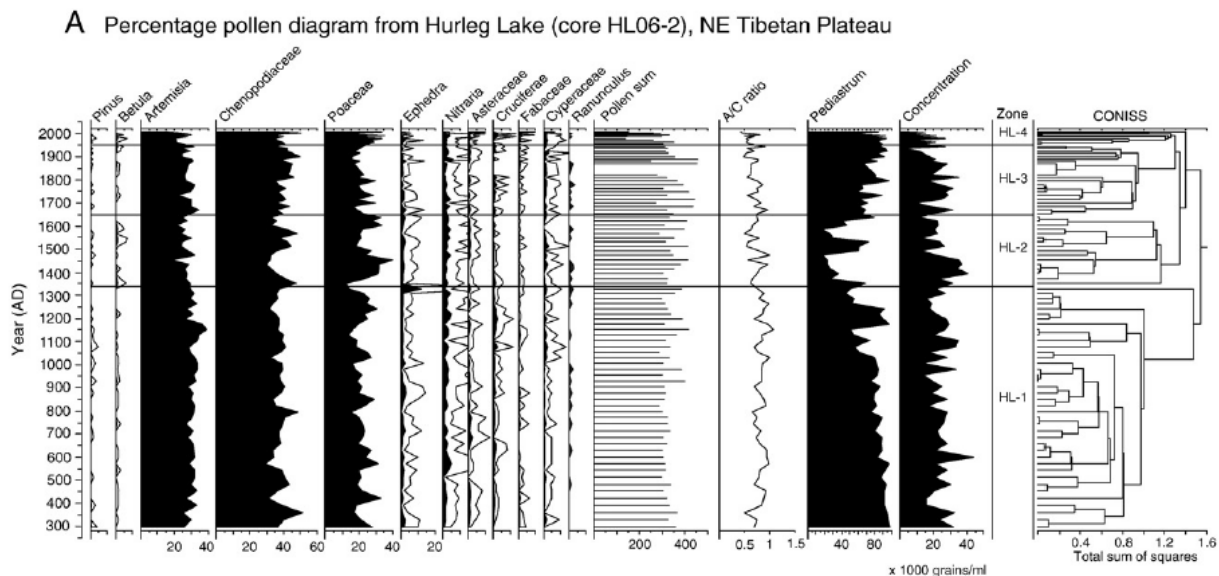


Fig.3.28. Zhao *et al.* (2010:66). Pollen Diagram of Hurleg Lake, NE Tibetan Plateau.

Zao *et al.* diagram shows the lack of *Pinus* and *Betula* trees from about the mid-thirteenth century until the early fourteenth century, around the same time as the climax of *Ephedra*. This would seem to indicate a lack of livestock grazing in the early to mid-fourteenth century. However, increasing *Poaceae* in the twelfth to the early-mid thirteenth century with the decrease of trees in the period are indicators that deforestation and clearance took place potentially for expanding pastoral lands. The diminished pollen concentration around this period also suggests the possibility of the effects of overgrazing and dust storms and the slight decline and more volatile A/C ratio suggests a bit drier and less stable environment.

Pollen Diagram of Bosten Lake, Northwest China

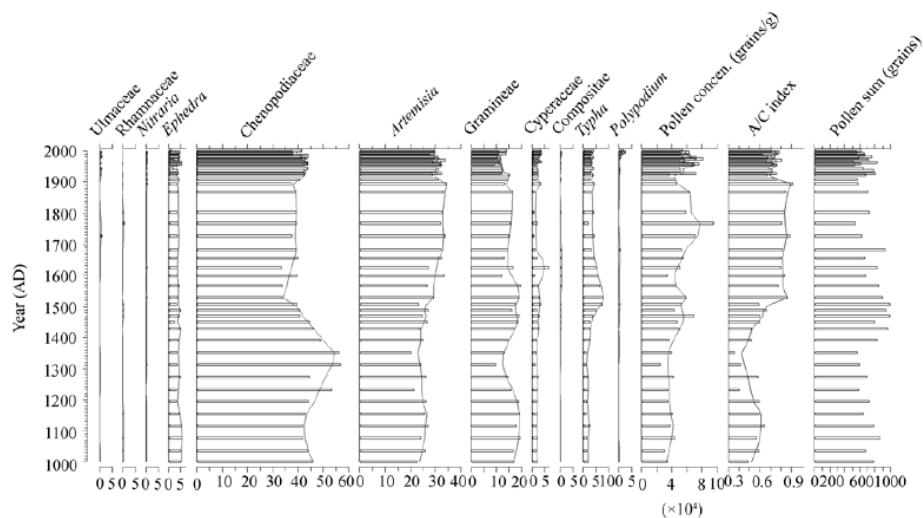


Fig.3.29. Chen *et al.* (2006:1284) Pollen diagram with Pollen assemblages, A/C ratio and pollen concentration of BST04H core (>1%), Bosten Lake, NW China

In Bosten Lake of Northwest China we see a decline of *Epiphedra* and *Poacea* (Gramineae) from around the late twelfth century while the A/C declines from about the same time, indicating increased dryness. Additionally, the pollen sum is too on a decline and also starts around the late twelfth century and does not begin to rebound until around the late fourteenth century. Though this diagram is not as dramatic as what was indicated in Mongolia or the on the Tibetan Plateau, the same indicators are present (Zhao et al. 2010:66).

Precipitation quantity (mm/year) of the Russian Steppes in the southern Lower Volga to the Ergeni uplands

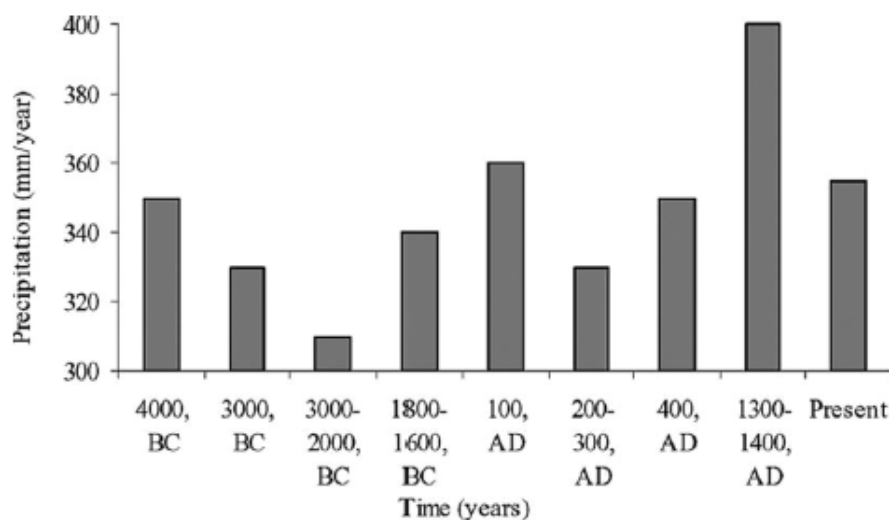


Fig.3.30. Mitusov *et al.*'s (2009:1157) reconstruction of precipitation

quantity (mm/year) in the southern Lower Volga to the Ergeni uplands. Graph is based upon Demkin *et al.*'s table 2 data of samples of more than 300 burial mounds based upon magnetic parameters of buried soils.

The Russian Steppes are another example of this phenomenon that took place of greater general precipitation that led to the expansion of Mongol herds, which fostered a process of aridisation. Demkin *et al.* explain the evidence for increased humidity that seemed to welcome in the Mongolian Tatars, known as the Golden Horde in the mid-thirteenth century,

The high Middle Ages were a time of increased climatic humidity with a peak in the 13th–14th centuries, during the Golden Horde period. For this time interval, the reconstruction of the mean annual precipitation has been done on the basis of data on the magnetic susceptibility in the surface soils and buried paleosols from different climatic zones. The calculations show that the mean annual precipitation in the high Middle Ages could have varied from 370 to 420 mm, exceeding the modern values by 30–80 mm (Demkin *et al.*,2006:124).

The establishment of the Golden Horde was no small feat as Demkin *et al.* note, it was the largest European state in the medieval period with centralised control “over politics, economy, trade, and military activity in the steppes of Eastern Europe” (Demkin *et al.*,2006:124). Demkin *et al.* add that it was during this time that the “nomadic tribes in the Lower Volga region established their first permanent settlements and practiced crop cultivation” (Demkin *et al.*,2006:116). However, during the mid-fourteenth century the boundaries became unstable as internal feudal wars undermined the power of the Golden Horde (Demkin *et al.*,2006:116). Interestingly, this is also the time the grasslands of the lower Volga experienced increased pressure on its carrying capacity, which Ryskov *et al.* observed,

...is identified from the carbon isotope composition of humus, whereas the $\delta^{18}\text{O}$ -values of bone phosphates, on the contrary, indicate a substantial increase in atmospheric precipitation and/or a decrease in temperatures. Such a process is likely to be associated with the stabilization of the life of the ancient nomads when the Khanate Golden Horde was in the making, and with the increase of the size of their herds. Records indicate that at that time there appeared a large number of settlements in the neighborhood of Sarai-Berke, the capital of the Golden Horde [24]. And since the settlement of Abganerovo is at a short distance (about 100 km) from it, it is natural that the load on pastures has also increased dramatically in this area (Ryskov *et al.*,2009:192).

This conflict of local factors and large-scale climatic records led to the Ryskov *et al.* conclusion that “the opposing tendencies of climatic indicators (humidity, temperature) as determined in this study were caused by the anthropogenic factor (overgrazing).” Khomutova *et al.* also observed the humid period that the Golden Horde arrived in, but also detected that “the paleosol of the Golden Horde time was buried in more arid conditions compared to the modern time, which was traced in the high content of viable microbial biomass in the Bk horizon” (Khomutova, Demkina and Demkin 2014:122) Ryskov *et al.* concurred with this assessment and explained the evidence for aridisation that occurred during the Golden Herd era:

...[the] $\delta^{13}\text{C}$ -values of humus [in the 13th-14th centuries]... were heavier than those for contemporaneous soils ($\delta^{13}\text{C}$ from -21.3 to -22.4‰)... This indicates a considerable aridization of climate...[W]e do see the phenomenon of anthropogenic aridization resulting from the isotope composition ($\delta^{13}\text{C}$) of collagen of human bones and soil humus from the medieval burial places of the settlement of Abganerovo” (Ryskov, 2009:191)

Khomutova *et al.* demonstrates the chemical data of sub-kurgan soils on the table below:

Table 3.3. Khomutova et al.’s (2014:117-118) Table of chemical properties of the sub-kurgan soils and modern surface soils of “Salomatino”
Khomutova et al.’s (2014:117-118) Moisture and chemical properties of the sub-kurgan soils and modern surface soils of “Salomatino”

Horizon. Depth, cm	pH _{H2O}	C _{org} %	Soil salinity%	CaCO ₃ content%	Gypsum content%	Particle-size distribution%		Moisture%
						<0.001 mm	<0.01 mm	
Kastanozem. 1500–1600 cal BC.								
Soil Section D-652, kurgan 2. Bronze Ages (Srubnaya culture)								
Aeb. 0–9	8.3	0.44	0.07	1.8	0.01	14	29	7.1
Btb. 9–24	8.7	0.35	0.09	3.0	0.01	18	34	5.4
Bkb. 24–34	8.8	0.13	0.06	1.5	0.01	11	18	5.6
Kastanozem. 150–250 cal AD.								
Soil Section D-655, kurgan 3. Early Iron Ages (Late Sarmatian culture)								
Aeb. 0–12	8.7	0.88	0.06	1.6	0.00	10	26	7.1
Btb. 12–23	9.1	0.64	0.08	1.5	0.00	25	42	9.8
Bkb. 23–37	9.3	0.49	0.10	12.4	0.04	24	39	5.8
Kastanozem. 1300–1400 cal AD.								
Soil Section D-654, kurgan 1. the Middle Ages (Golden Horde time)								
Aehb. 0–6	8.3	0.91	0.14	0.0	0.08	5	17	4.3
Aeb. 6–21	7.0	0.79	0.15	0.0	0.21	10	25	6.8

Btb. 21–40	6.8	0.52	0.27	0.0	0.21	21	39	10.0
Bkb. 40–50	7.6	0.35	0.16	0.7	0.01	14	21	6.6
Modern surface Kastanozem. Soil Section D-648								
Aeh. 0–11	6.7	1.61	0.05	0.0	0.00	8	26	3.2
AE. 11–30	6.5	0.80	0.02	0.0	0.00	13	28	3.7
Bt. 30–53	7.3	0.64	0.04	0.0	0.00	31	40	6.9
Bk. 53–65	8.2	0.44	0.05	0.9	0.00	18	27	2.9
Solonetz 150–250 cal AD.								
Soil Section D-653, Early Iron Ages. (Late Sarmatian culture)								
EAb. 0–11	8.9	0.44	0.12	0.5	0.09	11	24	3.5
Btmb. 11–26	8.8	0.97	0.34	1.9	0.02	33	52	12.3
Bkb. 26–49	8.6	0.17	0.55	4.6	0.23	29	43	14.3
Modern surface Solonetz. Soil Section D-651								
EA. 0–13	6.7	0.75	0.03	0.0	0.00	7	28	2.8
Btm. 13–30	8.6	0.88	0.25	2.2	0.00	41	56	13.2
Bk. 30–45	9.0	0.41	0.30	6.4	0.00	30	46	11.0

Notice that that relatively high soil moisture content (i.e. 10% or above) is also associated with the highest rates for soil salinity, as seen with the 10% soil moisture and the 0.27% of soil salinity seen at the depth level of 21-40cm of Kastanozem during the time of the Golden Horde. Additionally, the notable presence of gypsum at 0.21% at 6-20cm and 21-40cm depth levels at Kastanozem are at climate with an exception of a point at 0.23% when the soil moisture was at 14.3% (Solonetz at 26-49cm.). Gypsum, as soil salinity content is an indicator of salinized soils, is able to be recognised in the soil as a hydrated evaporate material (resulted from a process of combining with water and evaporation) (Dehaan and Taylor, 2002:416).

The increase in gypsum and soil salinity indicate greater rates of evaporation, which amplify as herding densities and grazing pressures intensify, all of which indicate a risk of aridisation taking hold. What comes with these ecological changes is where the risk of a plague epidemic augment, as these dense herds rarely comes alone. Additionally, the ecological demands on these lands were intensifying, as Nedashkovsky (2012: 225) explains,

...the khans built their own cities in the Lower Volga where before them there was virtually no settled population and even the nomadic presence sparse. The heydays of these cities, also including, between others, Saray, Saray al-Djedid, Haji-Tarkhan and Ukek, was the first half of the 14th century. ... The Golden Horde experienced in heyday during the reign of the Khans Uzbek (1312-1342) — under whom, in 1312, Islam was accepted as the state religion. (Nedashkovsky 2012: 225)

The ecological stress for resources on lands these lands that previously did not support settlement must have been substantial, especially during the climatic period for the Golden Horde in the reign of Khans Uzbek (1312-1342). These settlements of the Lower Volga region were also supporting livestock, with bone evidence from cows, bulls, oxen, sheep, goats, horses, camels, pigs, dogs, cats,

chickens, and ducks have been found (Nedashkovskii 2014: 39). Nedashkovsky (2016: 156) illustrates below that the settlement areas are highest in the late thirteenth to the mid-fourteenth century, thereby diminishing change making it easier for potential *Y.pestis* reservoirs to form.

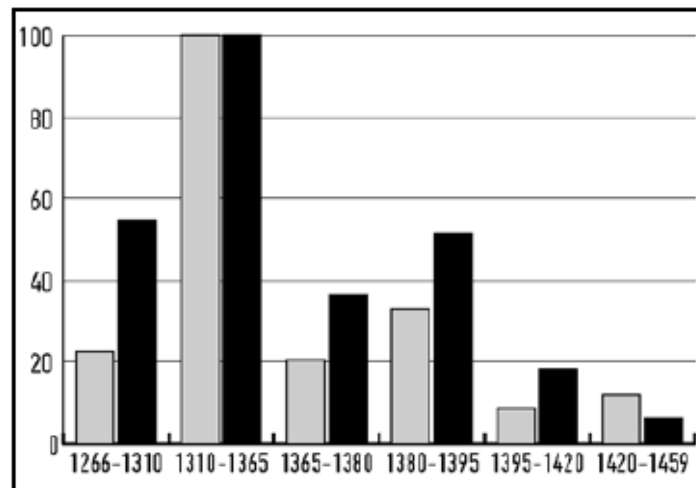


Fig.3.31. Quantity of Sites & Settlements in the environs of the Large Golden Horde Cities in the Lower Volga Region in Percentage Relative to 1310-1365 (Nedashkovsky 2016: 156). Chronological distribution of sites (grey) and settlements (black) in the environs of the large Golden Horde cities in the Lower Volga Region, shown as percentage of the total number of 1310-1365 sites and settlements of the region, respectively.

The increase of sites and settlements from the late thirteenth century to the mid-fourteenth century also provided the context for the establishment of the Tatar literary language from the early fourteenth century (Nurieva 2014:717), which according to Nurieva (2014: 713) “is considered to be the recension of the Volga region Turkic literary language...The detailed examination shows that the Golden Horde literary language was formed basing on centuries-old all-Turkic literary traditions...”(Nurieva 2014: 713) This illustrates the substantial cultural transformation from a semi-nomadic herding people to becoming a settler population that integrates people from a wide region and is less tied to a particular cultural geography.

VI Overgrazed Grasslands and the Emergence of *Y.pestis* Reservoirs and Potential Host Populations

3.17 Overgrazing and the Subsequent Boom in Burrowing Rodent Population

The relationship of burrowing rodent populations to high grazing areas has been observed in Mongolia, China, the Tibetan Plateau as well as the Russian Steppes. On the Tibetan Plateau, the population density of borrowing rodents, pikas and zokors have increased as domesticated animals lowered the vegetation cover (Shi,1983:181-187, Smith and Foggin, 1999:238). Additionally Smith and Foggin (1999:238) observed that pikas are “more likely to contribute to the deterioration of rangelands that are already overgrazed.” (See also Cincotta *et al.* 1992:3-25). Smith and Foggin note that pikas “tend to eat those plants that livestock do not eat” except when the “pika density is extremely high (such as is found in situations where rangelands are already heavily grazed)” (Smith and Foggin, 1999:238). The argument here is that burrowing rodents as the pika and zokors tend to eat vegetation that is unpalatable or poisonous to livestock, while these rodents thus diminish the plant presence of that which livestock tends not to eat, giving a greater opportunity for vegetation that is palatable for livestock to grow. However, overgrazing leads to diminishing food sources for both rodents and domesticated livestock)”(Smith and Foggin, 1999:238). This phenomenon of pastoral degradation with the increase presence of burrowing rodents has also been seen with the marmot population, which is native to Mongolia and much of central and western Asia. Ronkin, Sevchenko and Tokarsky (2009) illustrate this relationship below:

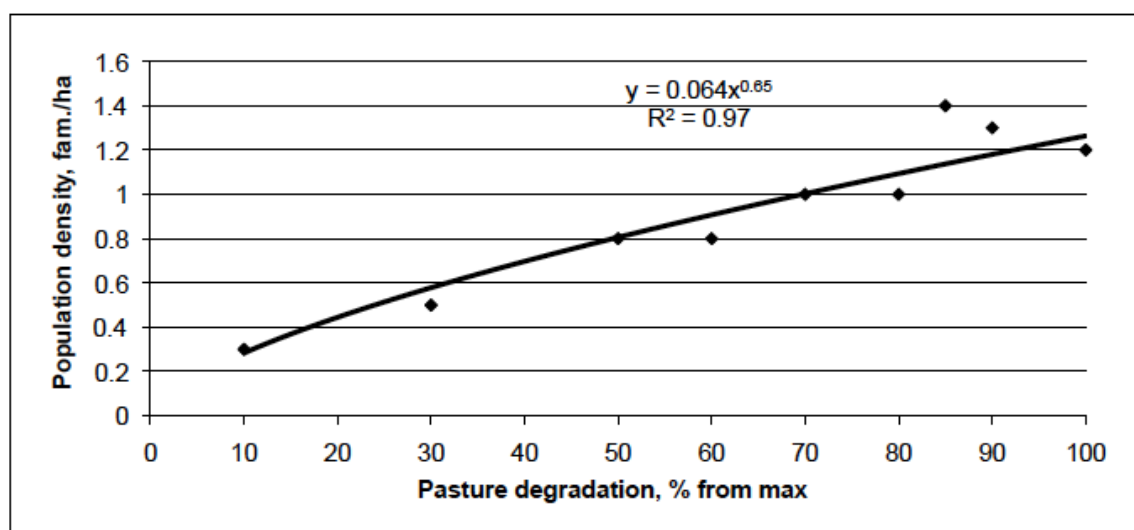


Fig. 3.32. — Relationship between density of the marmot population (fam./ha) and the degree of pasture degradation (in per cent from maximal degradation corresponding to the latest V stage described by Ramensky

1971). Data based on direct observations in the Regional Landscape Park, “The Veliki Burluk-steppe” from 1992 to 2008 (Ronkin, Savchenko and Tokarsky, 2009:282).

Ronkin, Sevchenko and Tokarsky graph illustrates this clear link between increased pasture degradation and marmot populations as is seen in many other burrowing rodents. Ronkin, Sevchenko and Tokarsky reviewed studies of the change of the marmot populations and grazing pressures over time and found that at the beginning of the twentieth century “the steppe marmot inhabited only the territories around the horse farms” (Ronkin, Savchenko and Tokarsky, 2009:283). However, this marmot inhabitation shifted in the late 1950’s when the USSR undertook a policy promoting agricultural growth. Ronkin, Sevchenko and Tokarsky explain,

The areas of ploughed lands and the number of livestock were increased significantly while the areas of hayfields and pastures were reduced at the same time. Thus, the grazing pressure on the pasture areas (i.e. gullies) was greatly increased and the foraging base for the marmot radically improved, because the grazing provides during the entire active season a high accessibility to young parts of forage plants for the steppe marmot (Ronkin, Savchenko and Tokarsky, 2009:283).

The marmot population following the grazing pressure was also observed by Ronkin, Sevchenko and Tokarsky when cattle numbers fell and the grazing pressure became more variable. They concluded that the “success of the marmot population is determined by the vegetation accompanying the late stage of pasture degradation” (Ronkin, Savchenko and Tokarsky, 2009:283-284)

3.18 Burrowing Rodents and the connection to the Plague

Meerburg, Singleton, and Kijlstra (2009:222) observed that there are two basic pathways that rodents can transmit rodent-borne diseases to humans. They explain,

The first pathway is a direct route. Rodents can spread pathogens to humans, e.g., by biting them or because humans consume food products or water that is contaminated with rodent feces. Moreover, humans can come in contact with surface water that is contaminated with rodent urine (e.g., leptospirosis) or we breathe in germs that are present in rodent excrements (e.g., hantaviruses). Also, rodents are sometimes mentioned in relation to horizontal transmission of pathogens that cause animal diseases, thus causing huge economic damages and image losses

for animal husbandry. Beside highly contagious viral pathogens such as classical swine fever, and foot and mouth disease also bacterial infections (e.g., *Mycobacterium avium*) need to be addressed in this respect (Meerburg, Singleton, and Kijlstra2009:222).

This direct transmission from the rodent population is heightened when people are in close proximity to the rodent population (See Begon's and McMichael's vulnerability factors for a zoonotic epidemic). This direct transmission is through exposure to the rodents themselves (by being bitten by the rodent) or their bodily fluids. However, indirect transmission is also common as Meerburg, Singleton, and Kijlstra observed,

...rodents can serve as amplifying hosts of the pathogens and can bring them into direct contact with humans by mean of ectoparasitic arthropod vectors (ticks, mites, fleas). Rodents that are accidentally or on purpose ingested by livestock can transfer pathogens which can result in human morbidity if these food products are not-thoroughly cooked. Moreover, rodents can help to maintain pathogen transmission cycles in a number of different environments, varying from densely populated urban areas to rural areas and in the wilderness. The number of different pathogens to whose life cycle rodents contribute in one way or another, is impressive (Meerburg, Singleton, and Kijlstra2009:222).

The indirect pathway of the transmission of rodent-borne disease to humans illustrates the vulnerability of livestock that are grazing on the same intensely grazed lands as the rodents. Thus, rodent excretion onto grasses that are then eaten by the livestock potentially may lead to an infected domesticated animal (as thought to be the case with cattle and foot-and-mouth disease) (Capel-Edwards, 1970). Since humans can contract disease through the consumption of animal products, there is a significant risk here. Additionally, humans being in close proximity of these domesticated animals also increase the vulnerability of transmission through the bite of an arthropod living on the livestock and carrying the pathogen. Meerburg, Singleton, and Kijlstra illustrate these two common pathways for the transmission of rodent-borne diseases to humans below:

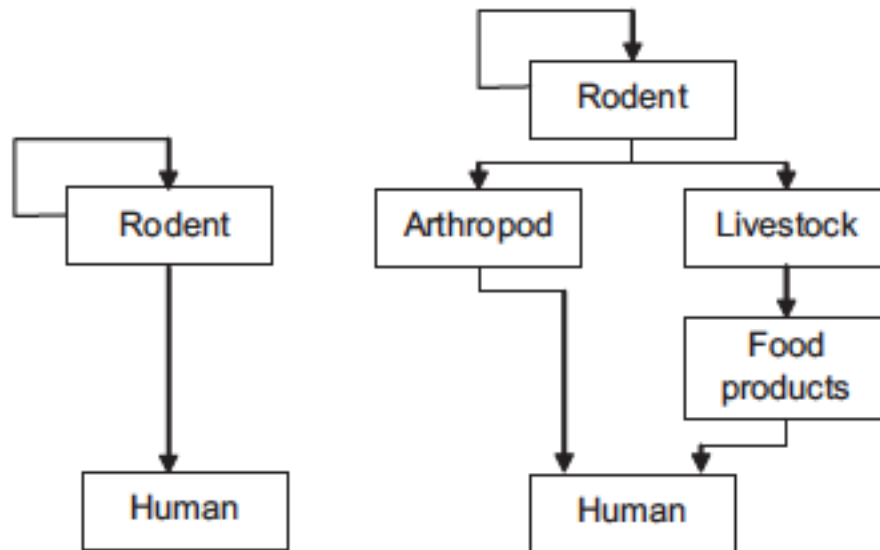


Fig. 3.33. Two different pathogen transmission pathways: on the left the direct route, on the right the indirect route. The pathogen is the arrow in the flowchart (Meerburg, Singleton, and Kijlstra, 2009:222).

The probability of rodent populations contracting a disease is dependent upon many factors, including climate (temperature and wetness), which is connected to the survival and reproductive rates of the rodent population. Climate is important for food availability for sylvatic and field rodents, which largely depend upon insects, vegetation, and seeds for their diets. Changes habitat that alters the microclimate, resource availability, predatory risk, and key substrates are factors that may lead to rodent migration (Meerburg, Singleton, and Kijlstra, 2009:222). These habit and climatic changes are also important for the lives of pathogens, as Davis *et al.* observed that *Yersinia pestis* is sustained within the gerbil populations in Kazakhstan. The prevalence of the bacterium in the gerbil population is affected by the degree of contact with the main reservoir host of the pathogen, the giant gerbil (Davis et al., 2004:736). Ari *et al.* below illustrate how climatic changes from the micro- or burrow climate to regional climate change come into play in influencing the different population levels of Plague, as seen in the gerbil population:

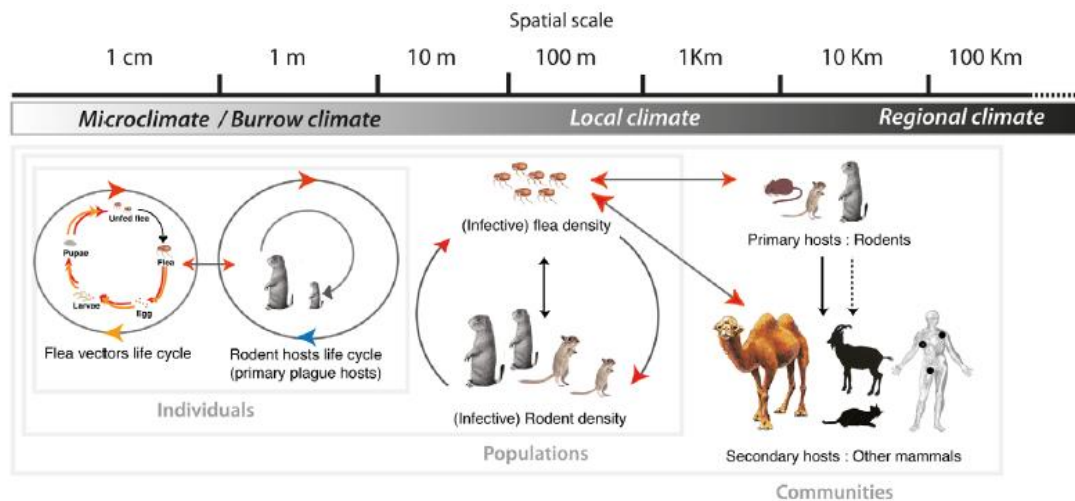


Fig. 3.34. Ari *et al.* (2011: 4) illustrate the impact climate has “on the plague cycle as a function of spatial scale,” with the arrows representing the “connections affected by climate.”

As more ideal temperatures and ecologies for population growth from the pathogen, vector, and hosts are realised, then there is a subsequent increase risk of contact from one host species to another. Habitat and climatic changes are crucial for vector abundance, as temperature and climate affect the ecology that arthropods can thrive within. This leads to a greater risk of rodents becoming hosts to the pathogen being carried by the vector, and rodent burrows potentially being a reservoir for the pathogen. The context that promotes disease of rodent populations also promotes the transmission of the Plague to secondary hosts, as livestock and humans shown in the diagram above. Stenseth *et al.* (2006) demonstrate in the graph below the climatic effects of spring temperature and summer rainfall on the prevalence of the Plague in gerbils from 1949-1995 in an area just southeast of Lake Balkhash in Kazakhstan:

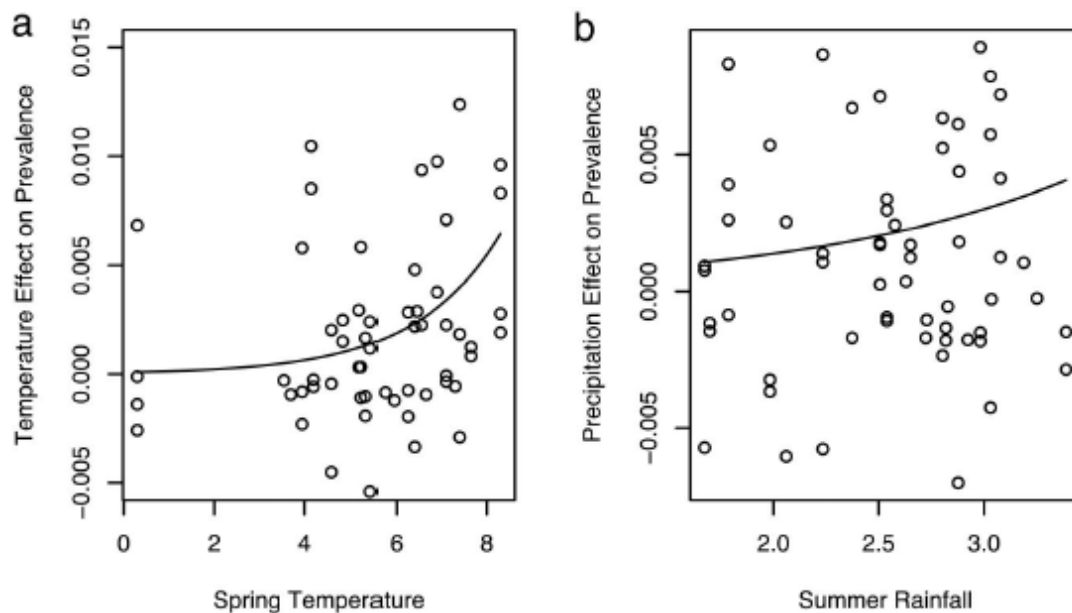


Fig.3.35. Each circle represents a Plague case in a region southeast of Lake Balkhash in Kazakhstan from field data of 1949 to 1995. The temperature is given in degrees in Celsius and rainfall is in untransformed rainfall data in millimetres (Stenseth, 2006:13112).

Note that the spring temperature is especially crucial here, as very few cases of the Plague are seen when the temperature was below 4 degrees Celcius. Stenseth *et al.* found a 1 degree increase in spring led to a >50% increase in prevalence based on the field data from 1949 to 1995. As stated before, this temperature increase may augment food availability and reproduction in rodents, thereby potentially developing a reservoir for the Plague in rodent burrows. Bush *et al.* also observed that burrows tend to be in close proximity to plant food sources (Busch, 2000:185) and that the digging of burrows is more advantageous for rodents after the soil was previously loosened by precipitation (Busch, 2000:190). There are many known and unknown variables that contribute to rodent-borne disease, of which the Bubonic Plague can be included as an example. Factors leading to rodent-borne disease are intrinsically interconnected as Meerburg, Singleton and Kijlstra's simplified model below illustrates:

Rodent Disease Model

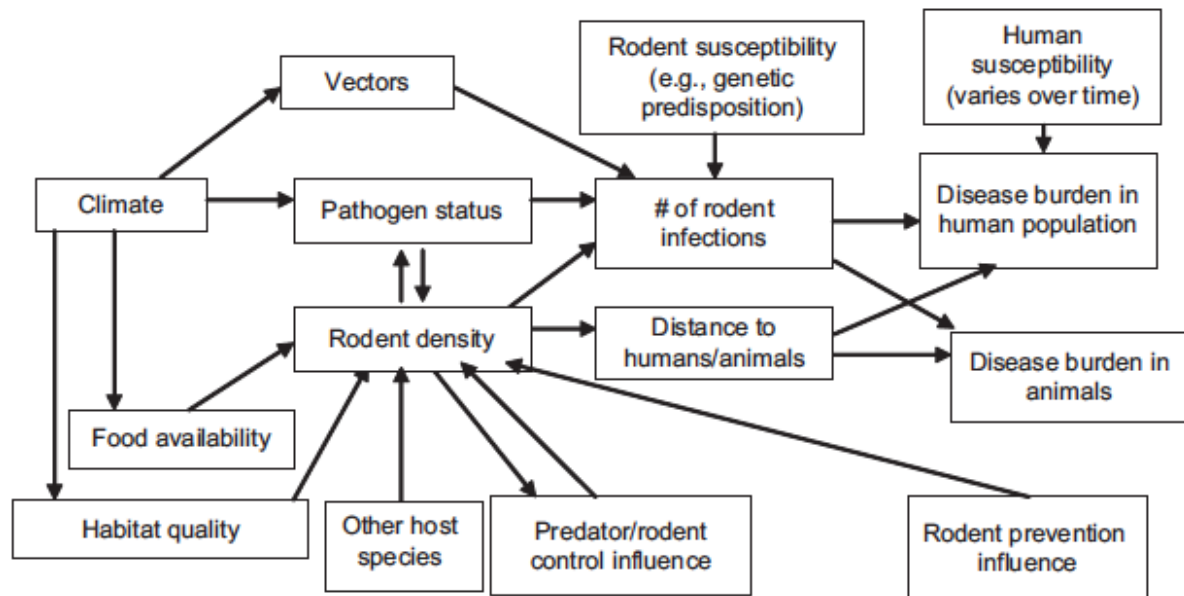


Fig.3.36. Meerburg, Singleton, and Kijlstra's (2009:252) simplified rodent disease model illustrates different factors that increase the risk of rodent disease. The arrows represent how the presence of a certain factor intensifies risk by increasing the presence of other interconnected factor(s).

Notice that the *rodent density* is the greatest factor here which is interconnected with many other factors as *food availability*. The increase of *food availability* allows for the *rodent density* to increase, but this population increase also puts increased pressure on the *food availability* that eventually could lead to an insufficient supply leading to a pressure for the population to migrate to areas of greater food availability or risk malnutrition. Each of the characteristics affecting *rodent density* may lead to its population increase or decrease, while *rodent density* affects the *number of rodent infections* and the *distance to humans/animals*. Thus, as the *rodent density* increases both the *number of rodent infections* and the exposure of humans and animals to rodents increases, leading to a *greater disease burden in animals and humans*.

3.19 Elevated Risk of Livestock and Human Populations to Zoonotic Epidemics in mid-14th Century Europe & Mamluk Empire

The greater risk of livestock contracting zoonotic diseases from rodents as herds increase in size and density can also be seen in the transformation of the landscape. Bush *et al.* (2000) believe that the aridization of the landscape and

the emergence of open-country have led to our present boom of subterranean rodents, they observed that “modern subterranean rodents are primarily in non-forest biomes such as grasslands, savannas, steppes, and deserts”(Busch, 2000:184). The dwindling of forest environments to make room for agriculture and animal husbandry was characteristic of Europe from the eighth century until the eve of Black Death.

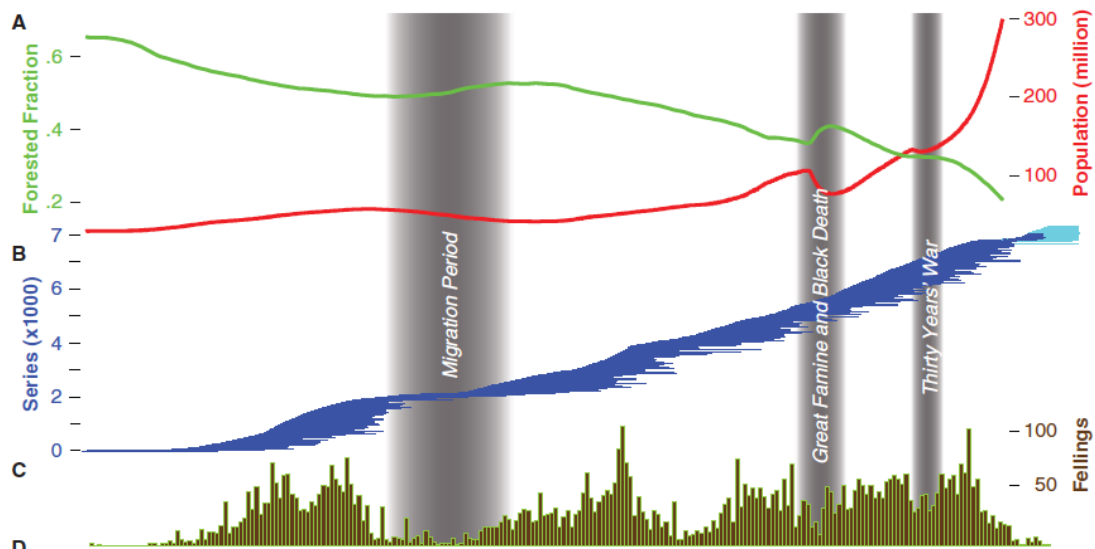


Fig.3.37. Büntgen *et al.* (2011:580) explain, « (A to D) Evolution of central European forest cover and population from (22) (A), together with oak sample replication (B), their historical end dates at decadal resolution (C), and examples of archaeological (left), subfossil, historical, and recent (right) sample sources (D). »

Notice the graph by Dotterweich (2013:4) of central Europe with the decrease of the forest (green line) while the population. Central Europe cannot be said to be more extreme than Western Europe in these regards, but an example of the deforestation and clearance that was taking place leading up to the fourteenth century. Increasing uncertainty of crop yield as low yields and crop failures, culminating with the Great Famine (1315-1317) would have forced greater dependency upon livestock, as these animals can consume a broader range of vegetation than humans are able to consume. However, greater livestock herd densities would have brought another set of risks with it, especially in close proximity to agricultural fields with grain storage, which would have been feasted upon by the burrowing rodents that would have accompanied the herds.

An earlier graph, *Erosion of the Land in Central Europe* in chapter 1, Dotterweich (2013: 4) illustrated the unprecedented erosion rate in central Europe that took place on the eve of Black Death, which is almost double the rate of the next highest erosion rate that took place in the late eighteenth century. There were actually two peaks of the erosion rate in the early to mid-fourteenth century, with the first coming at the climax of land use percentage of pastoral grasslands on the 1400 year survey, and agricultural fields had the highest peak seen until the nineteenth century. This strong correlation between deforestation and torrential flooding and severe erosion has been seen in the Middle Ages by the inhabitants of alpine valleys of southern Europe (Descroix and Gautier 2002: 54), which may have led to the dense forests up until the French Revolution and with that the containment of erosion (Descroix and Gautier 2002:75). This connection was then relearnt by nineteenth century forestry engineers, and with that forest protection eventually became a priority again. Lang *et al.* (2003: 3328) illustrate why it became a priority,

The effects of land-use change in Germany during the past 1350 years have been modelled with climatic conditions held constant (Bork et al., 1998a). The drastic decrease in total biomass from AD 650 to AD 1300 reduced evapotranspiration (20%) and considerably raised total runoff (C60%). These effects are confirmed by field data.

Bork's study with the amount of precipitation being held constant indicates the surface runoff rate would have increased by 60% in 1300 due to deforestation and clearance! The capacity for hillsides to infiltrate rain would have been especially compromised with the lack of forests and shrubbery, as seen in the fifteenth century paintings below:



Fig.3.38. Landscape Paintings of 15th century of the Savoy in France

‘Les Tres Riches Heures du Duc de Berry’ which includes figurative landscape paintings of the Savoy in France (pm 2-5), Left: folio 48 recto, annunciation to the herdsmen; right: folio 88 recto, request for safeguard; both were painted by Jean Colombe (1467–1529 CE) (Dotterweich 2013: 6).

Notice in these paintings there seems to be evidence for gullies caused by soil erosion. According to Lang (2003: 3331), “During the medieval period, agricultural activity was widespread and intense for the first time, and thus the sensitivity of the landscape was for the first time high enough to allow for the occurrence of gullying.” The medieval gullying was also accompanied by “widespread colluviation and fan development commenced.” Additionally, “The ploughing horizons of fields not densely covered with summer crops were frequently totally eroded. Half of the total hillslope erosion [in Germany] since AD 650 occurred between AD1310 and 1350” (Lang 2003: 3328). This tremendous amount of erosion takes place within a context of human activity, which greatly increased the risk for severe erosion to take place. Montgomery (2007: 90-91) summarises this context,

From the eleventh to the thirteenth century, the amount of cultivated land more than doubled throughout western Europe. Agricultural expansion fueled the growth of towns and cities that gradually replaced feudal estates and monasteries as the cornerstone of Western civilization. Europe's best soils had been cleared of forest by about AD 1200. By the close of the thirteenth century, new settlements began plowing marginal lands with poor soils and steep terrain. Expansion of the area of planted fields allowed the population to keep growing. Doubling over a couple of centuries, by AD 1300 Europe's population reached eighty million. (Montgomery, 2007:90-91)

This unprecedented erosion and flooding event depended upon deforestation and clearance in order to expose the soil, allowing the top soil to be washed away along with leaching the soil of its nutrients, leaving infertile agricultural fields and bare grazing lands. Insecurity led to greater wealth build-up for military and defensive structures, as castles and walled cities, which demanded greater resource production, especially to feed those that were not facilitating their own. Cash-crop agriculture also led people to depend upon market prices for their basic needs, which often forced over-intensive agriculture and/or cultivating marginalized lands. Western-style agriculture needs many hands in the field to pick the crops when they ripen, basically all at the same time. Thus, population increases are associated with this type of agriculture. However, these led to activities that fostered this unusual erosion event of the mid-fourteenth century.

Slope-channel coupling

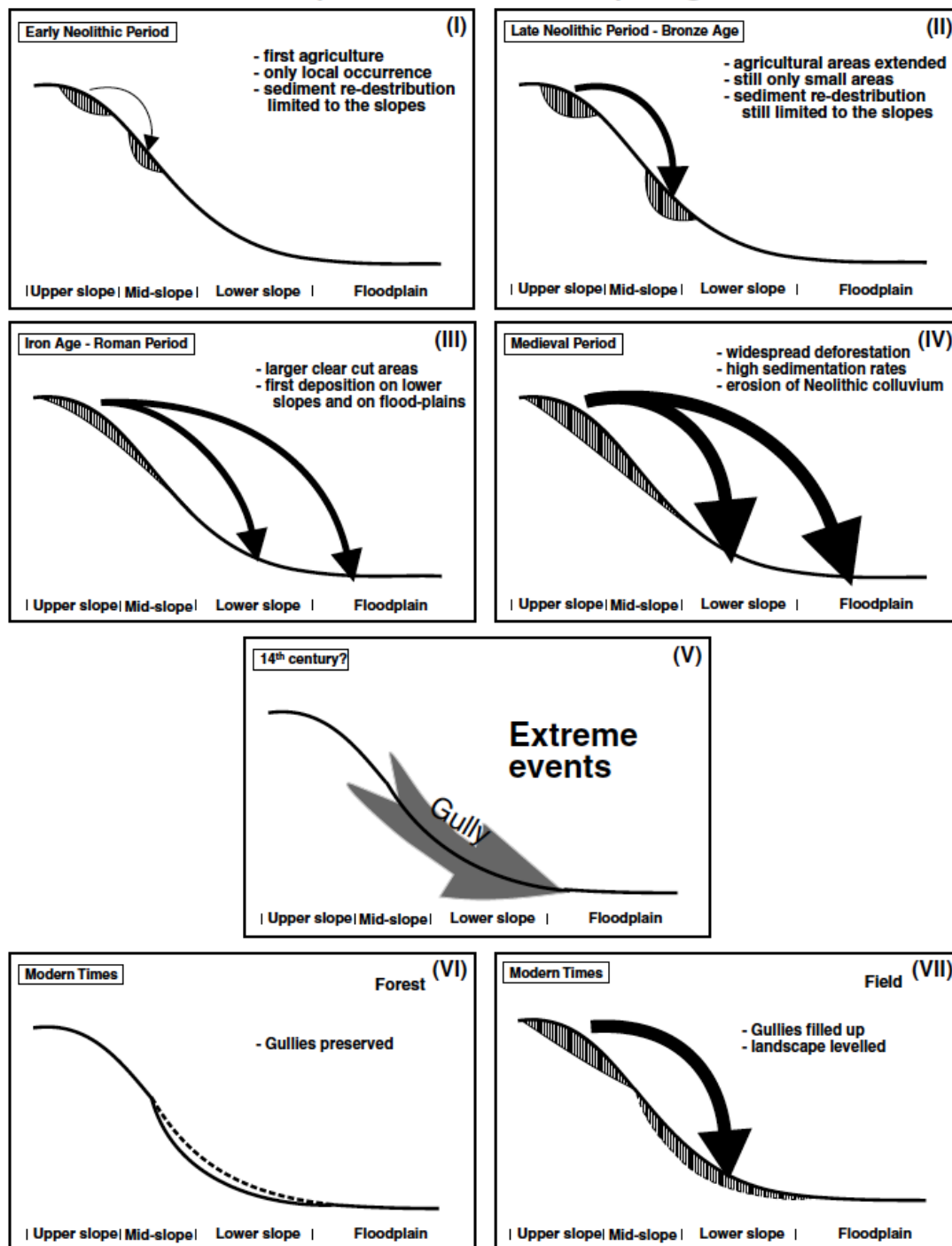


Fig.3.39. Conceptual model of changes in slope-channel coupling during the period of agriculture in central Europe (Lang *et al.* 2003: 3332).

The extreme erosion and flooding of the mid-fourteenth century Europe put people in greater risk for zoonotic disease, first and foremost because their bodies would not have been adequately prepared to fight off disease, as food

shortages would have led to malnutrition. The food that people did eat would have been at greater risk to give them disease, as Ergot (a fungus that develops from wet, often stored cereals, especially rye) and spoiled food.

The flooding also would have led to many animals to leave due to the lack of food in the area, and some to die. However, as it dried up an opportunity would have come for generalist species that could adapt to different food varieties, while many species would not be able to survive such conditions. Thus, quick-breeding opportunistic species, as borrowing rodents would have diminished competition for food and fewer predators. Actually, this process was already happening before the flood took place, as the forest was cleared for agriculture and grazing. McCormick (2003: 22) explains,

The clearing of fields at the expense of forest or wooded cover to feed the growing human population of antiquity, as of the later Middle Ages, ought to have caused a decline in the number of certain types of owl and other birds of prey, as well as rat-eating foxes and weasels. This removal of the natural checks on rodents occurred as burgeoning settlements multiplied their commensal opportunities, and spreading cereal fields increased their food of choice. Conversely, advancing woodland and its predators may have reduced rat populations in the early Middle Ages.

Therefore, the decrease in predators and food competition from other species allows a few more adaptive species to grow (and these rodents may be “better adapted to the per-domestic synanthropic environment than their predators and thus being ‘protected’ there” [Begon 2015]). These more opportunistic species are also more likely to be hosts to parasite insect vectors that spread infectious disease (Mills 2006: 10-12).

As the plant and animal life changes, so do the insects that need them to survive. If an opportunistic species booms in population, the pathogens that have adapted to their host will probably boom with it. The less change that is required for a pathogen to survive, the greater its chance for survival. Therefore a change in biodiversity affects the interconnection between thriving generalist species, infected fleas, and parasite pathogens. Vourc’h, Plantard and Morand (2012: 296) explain,

These generalist host species...often carry more diverse flea loads (number of fleas/host), both of which are associated with increased disease transmission. Second, increases in densities of generalist host species favors transmission of vectors and their pathogens. Third, disturbance can also favor generalist vector species, which are important determinants for the spread of zoonotic disease among wildlife populations due to their tendency to feed from a variety of taxa. For this reason, increased abundance of generalist vectors is strongly associated with increased parasite transmission and incidence of disease outbreaks in both human and wildlife population.

The Arabic records, paying much greater attention to ecology and biology than their European counterparts, give vivid accounts of the impact of rodents in agricultural areas. The impact of the rodents of the time in the Mamluk Empire is illustrated by Dols (1977), who paraphrases Baybars al-Mansūrī, Ibn Abī al-Fadā'il's, Ibn Taghrī Birdī and other contemporary accounts of the boom of rats that would occur around harvest time during the late thirteenth to the mid-fourteenth century,

...From the Mamlūk Period there are ample accounts of devastation which occurred in 696/1297 as a result of rats, whose number increased greatly in Egypt just before the time of harvest. According to the contemporary historian Baybars al-Mansūrī and others, packs of these rats had a race with *fellahin* in the fields, and the peasants were able to save only a small portion of their crops. Ibn Abī al-Fadā'il states that rats during that infestation destroyed the crops of about fifty *faddāns* in the course of one night in one village... there was a similar occurrence in 715/1315 when rats attacked the fields in Upper Egypt. Some officials in the village of Umm al-Qusūr in the Manfalūtiyya province killed a multitude of rats. According to Ibn Taghrī Birdī when these officials wanted to estimate the number of these dead rats, they used a grain measure. They found that in seven days they had killed the volume of 326 $\frac{2}{3}$ *irdabbs*. A report was written by them to be sent to Sultan al-Nāṣir Muhammad in Cairo. Al-Maqrīzī, who puts the figure at the amount of 316 $\frac{2}{3}$ *irrabbs*, states that when these officials tried to count the number of dead rats in a single *irdabb*, they found 8,400 rats in the *irdabb* and 1,400 rats in each *wayba* (one-sixth of an *irdabb*). The province of Manfalūt suffered another invasion of rats in 738/1337-8 which destroyed the crops in the fields and that stored in the granaries. Within one night a quarter of a whole granary was destroyed by rats. Two groups of *fellahin* in turn spent all night, with torches, and all day killing them. There were about sixty thousand *irdabbs* of beans lost for Sultan al-Nāṣir ibn Qalāwū in Manfalūt alone as a result of the rat incursion of that year. Damage to crops by rats is continuously mentioned in sources for later periods..."(Dols 1977, p.158)

Dols captures accounts of a systematic problem here that increased the conditions that favoured a boom of the rat population to take place in and around agricultural fields in Egypt. When Black Death occurred in the mid-fourteenth century, according to contemporary accounts of Ibn Iyās and as-Sulūk, many animals were devastated as agricultural beasts of burden as cattle/oxen that would have had a dramatic impact on cultivation and the peasantry (Dols 1977, p.156,159-160). as-Sulūk observed that depopulation was especially severe in Upper Egypt, as region of Asyūt where the Mamluk's used to collect taxes from around 6,000 people, but during Black Death only collected from 116 (Dols 1977, p.161). Contemporary Rabī' II in 749/June 1348 also observed, as Dol paraphrased that,

The people living in tents around Bilbais perished with their flocks and dogs, and the waterwheels in the countryside were stilled. The markets of Bilbais were deserted, for few would stay in the city. No muezzin was left to call the people to prayer, and a number of the inhabitants emigrated to Cairo. The population of this province (Sharqīyah) was unable to harvest their crops because of the high mortality rate among the peasantry and their flight from the land where plague had struck at the beginning of the summer. (Dols 1977, p.160)

Agricultural areas where people lived in close proximity to their domesticated animals seemed to have been especially at risk whereas regions that were less engaged in these realms have been documented to large escape the epidemic. as-Sulūk observed that areas that were known for trade and not known for agriculture, as Aswān, were minimally effected, only having 11 deaths, and Syrian towns of Ma'arrat an-Nu'mān, Shayzar, and al-Hārim also largely escaped the epidemic (Dols 1977, p.161).

The impact of vegetation re-growth in the previously cleared areas in the early to mid-fourteenth century may have led to more rodents to agricultural areas, as forests began to regenerate in these areas. Additionally, human populations were at very high historical levels, which would have meant higher population densities as cleared lands diminished. Then the cattle epidemic struck (1315-1325), which would have meant a dramatic change to the environment that the burrowing rodents were used to, and would have forced many of them to find a new niche. The people that looked after the cattle and fields that sustained most of these rodents were in closer proximity to these hosts of the Plague. Many

rodents likely died as their ideal environment was shrinking, *Y.pestis* needed to adapt to a new host, humans.

VII Discussion

Interdisciplinary and transdisciplinary research methodologies are uniquely designed to uncover the reasons behind the survival discrepancy of people living within different socio-economic systems that had different or more varied resource dependencies (Kreuter and De Rosa 2004:442). Developing greater awareness of resiliency and vulnerability is something that we certainly need more of in the present and investigating the past is the most concrete way to comprehend how these characteristics develop as well as recognizing what social consequences are tied to these changes.

3.20 The Spreading of *Y.pestis* from Central Asia westward

Regarding zoonotic epidemics as the Plague, DNA evidence of *Y. pestis* has highlighted the connection of the medieval past with recent outbreaks of the Plague (Bos *et al.* 2011:506-511; Bos *et al.* 2016:1-11; Cui *et al.* 2013: 577-582; Drancourt and Raoult 2016:1). The developments on the *Y.pestis* genome and genome mapping has delivered biological evidence on the Plague of the past that was previously largely unknown and thus necessitates changes in our research questions and perceptions of past plague epidemics (Bos *et al.* 2010 : 506-510 ; Bos *et al.* 2011:506-511; Bos *et al.* 2016:1-11; Cui *et al.* 2013: 577-582; Drancourt and Raoult 2016:1; Haensch *et al.* 2010:5; Krause 2016). The lack of mutation from most *Y.pestis* strains that are presently or recently existing, which originated from before Black Death of the mid-fourteenth century, is particularly intriguing (Bos *et al.* 2016:1-11; Bos *et al.* 2013 ; Cui *et al.* 2013: 577-582; Drancourt and Raoult 2016:1). This suggests some environmental characteristics may have been in common from different regions and during different time periods that has allowed *Y.pestis* to largely stay the same. The lack of mutation of the pathogen is indeed rare and leads to the question of how this was able to take place. This uncertainty highlights the importance of this investigation of the context of the bacterium's lack of mutation.

The Mongol Empire was just at its infancy in the late 12th and early 13th century as Chinggis Khan eventually ruled over other Mongol tribes to form authority that would continue to expand with the new territory gained. This expanded authority is exemplified by Mongol trading centres accommodating mobile courts (Honeychurch and Amartuvshin 2006:272) and the institution of *thousands* as the hierarchical administrative system implemented across the empire (Atwood 2012:1-76). The trading economy that the Khan oversaw and depended upon to support this expansive operation also transformed much of the countryside. This ecological change is illustrated by the wide variety of vegetables and spices (more than ten) and about twenty species of fruits and nuts found present in Karakorum that were cultivated locally, picked from the wilderness, or imported from as far away as Europe (Rösch, Fischer, and Märkle, 2005:286-492). Archaeological evidence suggested that the period of the strongest human impact to the local ecology came during the Middle Ages, while Karakorum served as the Mongol capital (Lehmkuhl, 2011:43). However, as substantial as cultivated vegetation may have been, the Mongols were especially known for their livestock and horses, which contemporary documentation indicate that they were seen in numbers never seen before (Nedashkovsky, 2014: 295-296).

The greater harvesting of particular ecosystem services that had market value may have been precipitated by a period of general increased wetness, which is seen in the pollen and dendrochronological evidence around Karakorum (Lehmkuhl *et al.*, 2011:41; Pederson *et al.* 2014:4375). The greater precipitation may have enticed the Mongols to expand their territory as the rangelands expanded (Pederson *et al.* ,2014:4375) to the Tibetan Plateau, (Grießinger *et al.*, 2016:4; Wernicke *et al.*, 2015:331; Zhang *et al.*, 2010:393-396), Europe-Hungary,(Büntgen, 2016:3,7), and the Russian Steppes (Alekseeva *et al.*, 2007:122,125; Mitusov *et al.*, 2009; Demkin *et al.*, 2006). Thus, as the great Mongol cavalry and foot soldiers extended their territory, so did their dependency on greater ecosystem services in the regions they occupied. This meant an especially strong dependency on herding and the hunting of wild

animals for consumption and trade in many areas of Mongol rule underwent a transformation (Nedashkovsky, 2014). From central Mongolia where we see this trend of deforestation, clearance, and expanded cultivation and herding, the Mongols moved to the Tibetan Plateau and then further west to the Russian Steppes, Europe and the eastern Mediterranean. These large-scale changes probably led to problems with overgrazing (Cao *et al.*, 2004; Du *et al.* 2004; Gao and Li, 2016; Lehmkuhl *et al.*, 2011:38-42; Munkhtsetseg *et al.*, 2017; Steffens *et al.*, 2008; Tong *et al.*, 2004), as erosion, which subsequently probably led to micro-, local, and regional climate change (Cao *et al.*, 2004; Findell *et al.*; Li *et al.* 2015:1-8; Luyssaert *et al.*, 2014:289-293; Mahmood *et al.*, 2014; Zhang *et al.*, 2001), as well as an increase in burrowing rodents (Bush *et al.*, 2000; Ronkin *et al.*, 2009; Shi, 1983:181-187; Smith and Foggin, 1999; Zhong *et al.*, 1985; Zhang *et al.* 1998). The changes that were brought about by the Empire also affected the risk of a zoonotic epidemic taking place within those populations (Ari *et al.*, 2011; Bush *et al.*, 2000; Davis *et al.*, 2004; Meerburg *et al.*, 2009; Singla *et al.* 2008; Stenseth *et al.* 2006). The high density of the livestock and people's close proximity to these animals increases the probability that the zoonotic disease subsequently passes to the domesticated animals and then to humans (Ari *et al.* 2011; Bush *et al.* 2000; Meerburg *et al.* 2009) as McMichael, Begon and Lauderhoffer vulnerability factors for such an epidemic indicated. This suggests that the socio-economic system that had been supported increased the risk factors for not only the continued survival, but large-scale expansion of *Y.pestis*.

Regional and local trade from the late thirteenth century expanded (Ertl 2006: 256-7; Smith 2003:7; Tabak 1996:23-48) with the settlements and greater population and livestock densities in the Golden Horde. Thus, the Golden Horde with its enormous herds and extensive trade with Europe and the Mamluk Empire point to *Y.pestis* reservoirs in the region that probably started by the time of the Mongol invasions in the region. The possibility of re-introductions of *Y.pestis* to this region becomes diminished after the mid-13th century as the Mongol Empire was no longer united. Thus, the long-distance trade that did occur in the mid-14th century would have likely been small scale, and therefore having less potential to initiate a large-scale re-introduction of *Y.pestis* and the

Plague. The larger-scale of trade grew regionally. Thus, the socio-economic foundations of animal husbandry and agricultural cultivation continued people's dependency upon the market economy as well as cash compensation. Large-scale production means greater incentive for specialization in order to maximize profit for commodities as wool and wheat that were in high international demand. This made labourers very dependent on the production level to the commodity they specialized in to obtain the cash they needed to survive. If they did not receive this compensation they were at risk of malnutrition, as they often needed the cash for basic needs.

3.21 Assessing Vulnerability for the Plague in the Mongol Empire & the Golden Horde

The Mongol Empire, the Golden Horde, Europe and the Mongol Empire present three distinct socio-economic realities and levels of risk for a human zoonotic epidemic, as the Plague. The Mongols were a people that traditionally depended upon herding as the backbone of their society, but rapidly transformed themselves to take over other lands and to rule over and incorporate the people of those lands to expand to become the largest empire up to that point in time. They integrated much knowledge, organization and socio-economic structures from those they came in contact with as well as those they took over, especially with the social organizational knowledge and institutions of the Jin Dynasty in China and the Persian, Arabic, and Islamic influence of trade and economic structures. This semi-nomadic heritage began to fundamentally change after the breakup of the Mongol Empire with the Golden Horde from the late thirteenth century with the influx of settlements until their downfall in the mid-fourteenth century. This large political region had huge herds that were traded at an unprecedented level to Europe and the Mamluk Empire.

Following Table 1 from the Methodology chapter, the Mongol Empire and the Golden Horde populations' risk for a zoonotic epidemic (based upon McMichael's, Begon's, and Laudisoit's risk factors) will be reviewed using the seven inquiries. These inquiries will be addressed in two groups, the first three

will form the first group, which concentrates on biological and ecological risk factors. The inquiries are:

- 1) Based upon the vulnerability factors for a human zoonotic epidemic,¹⁶ is there evidence of heightened risk at the site?
- 2) Is there evidence of food insecurity & malnutrition/co-infections?¹⁷
- 3) Is there evidence of deforestation, vegetative clearance, &/or erosion?¹⁸

The heightened vulnerability during the Mongol Empire, was seen in the high population and density of herds, which altered habitat, which is described in McMichael's vulnerability factors for a zoonotic epidemic noted earlier that included the following pertinent factors: *Altered habitat, with proliferation of reservoir or vector populations, Intensified farming and animal husbandry, and Niche invasion*, (McMichael, 2004: 1054-1057) which seem especially relevant in regards to the ordo camps and with the *thousands* in general. The intensified animal husbandry certainly was a niche invasion of its own in these small political-geographic entities, but they undoubtedly brought commensal rodents and organisms with them. The grazing intensity would have altered the vegetation as non-edible plant-life would have thrived while grasses and other edible vegetation would have become increasingly sparse. This would have led to what McMichael called, *Biodiversity change and habitat fragmentation*, as deforestation and overgrazing altered what species were favoured in the area. Consequently, some variation would have occurred due to the plant and animal life that depends upon certain niches, and changes to these niches leads to changes in their populations and health. Thus, these altered habitats would have led to McMichael's next factor, *Ecosystem changes, loss of predators and host species imbalance*, though the degree of these changes would pail in what would be seen in Europe or Mamluk landscapes. Additionally, deforestation and overgrazing will cause microclimate changes (McMicheal labels this risk *human-induced climate change*), which is critical in the formation of animal reservoirs for *Y.pestis*. Laudoit also notes the *Disturbance of interactions between species causing species range shifts and increased contacts with domestic animals and*

humans (one health), the Trade of forest products and bushmeat and the illegal or uncontrolled nature of the trade, and Bushmeat consumption. The Mongols hunted extensively around the areas that they settled and would use and trade fur and the meat of wild animals, as the marmot, which is known to commonly be a host of *Y.pestis*. The lowering of natural barriers between wild and domestic animals, as well as with those species and humans would have been compromised with the extensive hunting as well as deforestation and overgrazing, which is also one of Begon's vulnerability factors, *The increased interaction of area wildlife with humans*. The evidence suggests that the enormous, dense herds of the Mongols may have also attracted some commensal rodent populations that may have led to greater human exposure to animal reservoirs of *Y.pestis*.

Mongol vulnerability of food insecurity and malnutrition may have a good example of the risk as Karakorum shows substantial landscape changes in the early formation of the Mongol Empire, which included deforestation, irrigation canals, expansion of agricultural cultivation and grazing lands, while also increasing the importation of food from as far away as Europe. This does not mean that there was a food shortage, but it does show the much greater demand and the more extreme measures they were taking to increase their food supply. During the empire evidence of deforestation and high grazing pressure were commonly seen. These actions along with irrigation of cereals in settlement areas (as Karakorum) often led to evidence of erosion, as seen in the replacement of green algae by thecamoeba in Karakorum. These unsustainable practices (of the Mongols, Jin, Song and others) increased the risk of flooding, water erosion that resulted in sediment accumulation, which may have indeed led to increased dust storms in central Asia. The high degree of Mongol taxes (for horses, livestock and cereals) on those peoples whose lands they took over also would have led to unsustainable ecological practices in order to satisfy Mongol demands. The organisation units, *thousands*, were part of a centralised hierarchical system of territorial rule to sustain and strengthen the military. This system helped augment the size of the herds, especially of horses, through dividing lands into grazing unit areas, which were expected to sustain a certain amount of horses, livestock, and people. These were not sustainable units, but as Mongol territories expanded the horses, livestock, and people were frequently

redistributed on new lands. It was this mobility that may have diminished the Mongol risk, as the intensity of the exploitation of lands were typically not constant over decades, but in varying degrees of flux. Therefore, though people, as well as the horses and animals may have struggled for some years, they were also likely to move somewhere that they could more easily meet their needs before over-exploiting that area and eventually moving on to the next location. However, this was beginning to change in the Golden Horde with the escalation of settlements in the late thirteenth century and the unprecedented trade of livestock and furs to Europe and the Mamluk Empire. The influx of permanent settlements would have led to greater risk based on Begon's risk factor, *The increase potential for human to human transmission through greater population densities and increased movement both within and among different populations*, due to the larger populations of people from different geographies settling in close proximity to one another. Additionally, the density of livestock and the increased contact and dependency they would have on people for their survival would have also led to greater risk, as Laudisoit indicated, *Disturbance of interactions between species causing species range shifts and increased contacts with domestic animals and humans (one health)*. It is also likely that forest fragmentation became more common as the continual impact on forested areas would have been greater than was seen in the thousands, where people tended to migrate from more frequently. Additionally, more land would have been cleared for cultivation and grazing, as Laudisoit's risk factor, *Land-use changes and conversion of land in agricultural surface*, indicates would have created a more ideal environment for animal, especially rodent, reservoirs of *Y.pestis* to develop. Also, permanent settlement areas tend to have higher birth rates, which Laudisoit notes as a risk factor, *High population fertility and the population growth next to hotspots is higher than in non-forest areas*. This development, though just in its early stages is significant as high human population densities does not seem common in the Mongol Empire, rather it is the density of horses and livestock that was very significant. Therefore, if this was indeed the case, it would be difficult to see how a human Plague epidemic would have taken place in the Mamluk Empire, but it very well could have been seen in the livestock, horses, or commensal animals that accompanied them, as rodent populations.

However, this may have changed with the settlements of the Golden Horde that potentially settled with infected host animals around them.

The next set of inquiries focuses on the socio-economic systems and institutions that would have promoted human activity that led to the increased risk for an epidemic of a human zoonoses as the Plague. This group of inquiries are as follows:

- 4) Has there been an increasing emphasis on language built for trade over ecological observation?¹⁹
- 5) Is there evidence of trade/economic change leading to educational/enculturation change in society?²⁰
- 6) Is there evidence of growth in Social organisational size & complexity, which diminished the society's problem solving efficiency?²¹
- 7) Is there evidence of societal instigation of an ecological crisis through unsustainable socio-economic systems and institutions?²²

The Mongol Empire elites did not have a programs of education and enculturation as a point of emphasis as seen in Confusion China or the Church in Europe, rather it was the elites that made some effort to understand the lands, government and culture of the territories they took over. This was certainly true in China, where the Mongols largely ended up continuing the governmental and cultural institutions of previous dynasties and learnt the Chinese language and script. Maybe due to the realisation of the power of the written word, it is also at this time that the Mongolian script took form. The Buddhist Tibetans also had similar influences and had formed partnerships with the lamas, as they certainly released the influence these leaders had on area tribal peoples. However, it was Islam that led to the official conversion of the Mongols, and the influence of the Persian and Arab trade opened up new markets to the Mongols that they had limited access to previously. The Mongols, therefore, were frequently adapting and learning from one culture to the next. They were incorporating what they already learnt to the following destination, while, when deemed necessary, learnt and continued much of what a culture had been doing previously, thereby

gaining more support and access to horses, livestock, agricultural goods, and men to serve as soldiers. The Mongols focused on people paying, often very high, taxes in the form of horses, livestock and cereals, expanding trade links, and having male soldiers from the lands they conquered. It seems as though cultural, educational, and socio-organisational institutions were just a means that were sometimes used to gain access to these priorities. Nevertheless, there were rigid, centrally controlled aspects of Mongol rule that would have had deteriorating effects on local ecologies. The organisational unit, *Thousands*, being first and foremost a military focused organisational construction, where each was governed by a general, who was under the centralised control of the Khan and his kin, systematically did not incorporate the local environmental circumstances of each of these units. The grazing intensity of their horses and livestock as well as the high taxes often required of the local people often did not account for what the local ecologies could sustainably support. These aspects shows the lack of connection the Mongol's had with the local ecologies of the territories they took over. This is illustrated in the three focal points in Van der Leeuw (2009:47) in 'What drives socio-environmental systems regularly towards a crisis?.' *The Potential of the System* (in sustainably expanding ecosystem services needed by a population) was typically outstripped by the Mongol's socio-economic system, which was geared to exploit needed resources quickly. The ability of the Mongol's to observe and act upon environmental potential and the needs of the society, as Van der Leeuw calls, *(The) connectivity between (organizational) levels and the internal control variables and processes*, was not sufficient as the organization was concerned with getting military information to the Khan and was not structured to observe and act upon social or environmental needs within the *Thousands*. Therefore, the overall, as Van der Leeuw refers to as, *The adaptive capacity of the system*, is very limited. Thus, it is likely that ecological crisis may have impacted these regions in the way of overgrazing, dust storms, and famine, as the ecological services the Mongols were expecting from these region often outstripped their capacities and the organizational systems in place were not equipped for detecting such problems.

After the Empire broke apart, the Golden Horde began to change in the late thirteenth century with the rapid construction and expansion of settlements. This large political state in its own right had increasing dependence upon these permanent settlements that were formed of people from different parts of the state. It was here that the Tatar literary language was shaped from the all-Turkic literary traditions was established, which started in the early fourteenth century shortly after the large increase of settlements in the Volga region illustrates substantial change taking place in the decades before Black Death. While these changes were beginning and cannot be considered well established, they do show a change of cultural values and intellectual emphasis from the oral tradition to creating a more pluralistic written literary account. (Nurieva 2014: 713,717) However, the sharp decline of the settlements around the time of Black Death notes that the settlement areas probably were problematic during the period. While the same issues Van der Leeuw illustrates of environmental connection of the society can be applied to the Golden Horde as had been for the Mongol Empire, the Golden Horde had in its own best interest to instil a sustainable society, whereas the Mongol's were quickly expanding and attempting to accumulate resources as quickly as possible to be able to continue its expansion. However, with the rapid growth in settlement development of the Golden Horde had to develop larger and more complex socio-organisational systems and institutions that, as Tainter (1988:118) notes, tends to carry greater costs and less efficiency with such increases. Thus, the ability of these organisations to be effective at problem solving diminishes, which the downfall of the settlements during the time of Black Death seems to indicate.

Chapter 4

Societal Change and Vulnerability to Zoonotic Disease Epidemics: An assessment of the impact of escalating globalisation with a focus on Tanzania from the eve of colonialisation to the recent past

I. Introduction

Are infectious disease epidemics inherently a greater risk in tropical rural and urban areas of Africa, Latin America, and Asia? Was what has been called the greatest known epidemic, the Black Death of mid-14th century Europe and the Eastern Mediterranean, just an aberration? In contemporary media, we repeatedly see economically poorer, over-exploited areas with higher population densities as being high-risk areas. The *Y.pestis* genomic research in recent years has revealed that the mid-14th century pathogen that caused Black Death shows no evidence in being more virulent or contagiousness than the modern pathogen of the bubonic plague. Historically, the Justinian Plague at the end of the Roman Empire was said to disproportionately hit those living in the Mediterranean, who depended upon food imports at a time when Germanic peoples were invading the Empire (Schat 2005). This narrative of greater vulnerability of settlers tied to the system of agricultural production and the greater resiliency of those that had greater range of resources at their disposal was also seen during the next pandemic. During Black Death less centralised groups as the Irish Gaels (Richardson and Sayles, 1947:21; Ellis, 2006:182). and the Bedouin of the Mamluk Empire, (Hopley. 2016:178-179) as well as those of eroded manor power structures in central Sweden (Berglund *et al*; 2009:17, Emanuelsson *et al*. 2003; Ersgård 2016:98) were able to augment their territories and survive at a much better rate than their more politically centralised counterparts.

Anthropogenic impacts are seen as a crucial characteristic of risk factors for a zoonotic epidemic in human populations. Socio-economic stressors on ecosystems lead to biological vulnerability and continued development of zoonosis as a human threat. Language, education, and social enculturation set the foundation for a society's economy and social organisational system as well as epidemic risk. The case study example of inland Tanzania illustrates how the

impact of forces of globalisation through war, colonialism, slavery, migration, and unsustainable natural resource extraction increased the country's vulnerability for zoonotic epidemics since the 19th century.

This chapter focuses on inland Tanzania as the centre of a case study that concentrated on the pre-colonial eve of German occupation to the more recent years of independence, where the investigation focuses on Lushoto district in the highlands, which has suffered from periodic plague epidemics in recent decades. Large-scale voluntary and involuntary migrations in the last few generations to augment rural labour densities and production, especially for agricultural commodities and logging. This has led to greater dependencies upon cultivation of foreign species through western agriculture, which has led to problems in soil fertility, and zero-grazing animal husbandry. Forests have been fragmented through clearance for agriculture and animal husbandry, logging and firewood collection, which also increases the exposure to potential zoonotic hosts and vectors in the wildlife. The wildlife is forced to live smaller areas, which leads to greater exposure of livestock and human populations along forest edges and in the forest. However, those that show greater resilience are less connected to western systems of agriculture. The most resilient group, the Shambala (or Shambaa) people (or more correctly speakers of the Shambala language), was also living in the most forested area as well as being the most traditional people in the region hit by the plague living on the same lands for some 500 years.

This research is conducted through Participatory Rural Appraisal (PRA) methods, Laudisoit's, Begon's, and McMichael's vulnerability factors of zoonotic disease, van der Leeuw's *What drives socio-environmental systems regularly towards a crisis?* and Tainter's *four concepts that lead to understanding collapse*, if human activity based upon economic expansion and the cultural institutions that support the economic system have continued to heighten vulnerability of human zoonotic disease epidemics. This investigation first observes similarities of zoonotic disease epidemics around the world, which human activity has played a very prominent role in augmenting risk factors since the European Middle Ages. However, it is the socio-economic systems that foster these actions to develop, which has been cultivated through different forces of globalisation.

II. The African Experience

4.1 Agricultural food and cash crop production

In the process of searching for the key causes of the vulnerability of communities to zoonotic disease in Africa the colonial administrators began by establishing a relationship between the increase of crops production and the increase of the rat population in the affected areas. The increase of crops production attracted larger numbers of rats from the bush to the settlement of the people had most of the rats carried fleas, which may have spread bubonic plague. For instance the report of the senior medical officer stationed in Arusha Tanzania noted that “crops of maize and cotton have led to a greater increase in the rat population, which may have become infected by plague immune sylvatic rodent,”(TNA 1994:8)²³ and that “rat population is very, larger and is accounted for by the exceptionally good crops”(TNA 1994:8)²⁴. Africa has faced many food crises in recent decades (Clover, 2003: 5-15; Drimie ,2004; Headey and Fan 2010; Lagi, Bertrand and Bar-Yam, 2011; McMichael ,2009: 281; Misselhorn 2005; Nellesmann 2009). Are these just naturally occurring events or due to human activities that heighten risks of desertification? Are these post-colonial societies poorly observing and adapting to ecological changes that have taken place? Dinham and Hines (1984: 11) illustrate the precariousness in the lack of agricultural diversity in most African countries that have been underpinning these ecological crises:

Cash crops are vitally important in Africa. ***Twelve countries are dependent on just one crop for over 70 per cent of their income and a further eleven countries depend on only two crops for well over half their income***...Africa's trade in agricultural commodities is almost entirely with the industrialised world...links with the former colonial powers tend to be dominant, and without exception there is an adverse balance of trade with these former rulers...

The extreme lack of agricultural diversity that has based upon the demands of their former colonisers and other foreign markets, as the US, and more recently other markets as China, ties much of African economies to the market price of a

specific commodity. Thus, if international market prices go down, cash-croppers need to either cultivate more land, and/or cultivate their lands more intensively. However, as illustrated earlier, there are many vulnerabilities to this cash-cropping system. Fertility of the soil is always a very important issue as the crops continually demand and extract the same nutrients from the soil. Thus, these fields need to be fertilised, which is also intensified considering cash-cropping fields tend to be larger than other agricultural plots, thereby diminishing the amount of decay of leaves and plant-life from surrounding woodlands. This type of agriculture is also at higher risk of pests and disease, as the lack of diversity limits the ecological defences. Accordingly, this type of cultivation requires great investment for fertilizer, insecticides, pesticides, and the larger fields also require great capital for farm tools and machinery. Additionally, when there is a shortage of fertile lands and yields diminish, there is “a conflict between the need to grow cash crops for export and the need to grow food crops, and between supplying food for an urban population and ensuring that food supplies in the countryside remain abundant” (Dinham and Hines, 1984: 157). This is an unsustainable system that is used to quickly build up short-term wealth through a very substantial investment. This European and American style agriculture also requires great African investments from these foreign lands just to keep the agricultural system running. Thus, food production per capita was down over 20% for Sub-Saharan Africa from 1961 to 1978, while the cost of grain imports increased almost 600% during the same period (while the volume went up about 200%) (Dinham and Hines, 1984: 138-139).

Europe, whose own lack of food security and infectious disease epidemics have only reversed fortunes in the last century or two, has heightened ecological protections and diminished its dependency on its own raw materials and local agricultural production. However, during the last two centuries, there has been an increasing dependency upon raw materials and agricultural commodities from areas that have subsequently suffered from food insecurity and infectious disease. A recent example of raw material extraction for foreign markets, which has resulted in ecological degradation, and has been connected to an epidemic, is the surface diamond mining in Sierra Leone. Before the recent Ebola outbreak,

another haemorrhagic disease was already common, Lassa fever, in the same area where the more deadly Ebola would strike. McCormick *et al.* (1987: 437-438) illustrate the context that this epidemic took place in an actively deforested area of eastern Sierra Leone:

Agriculture (in the forested hills of eastern Sierra Leone) is small plot, manual cultivation of rice, manioc, sweet potatoes, and peanuts. Food is frequently stored in quantity in and around village houses, a practice that often results in an ample food supply for commensal rodents. The population of the entire province is <1 million people, with a large portion concentrated in the diamond-mining area. The site of the major part of these studies in the eastern province represents perhaps an extreme example of the kind of dislocation of humans occurring throughout much of Africa. Population movements are common, large, and often rapid upon the rumor of a new diamond find. In our experience, it is not uncommon to observe the population of a particular village double or halve over a one- to two-week period, depending on socioeconomic factors. The result is often a major disruption of certain segments of villages where it is not unusual to find up to 50 people occupying a single house. The houses do not have screened windows, so that they are usually closed up during the day, while people are working outside. This activity tends to extend the nocturnal activities of the commensal rodents.

All of these circumstances result in close and continuous contact between the human and rodent populations of the houses. Many of the people coming to the diamond-mining areas are from neighboring countries or from coastal areas where the prevalence of antibodies to Lassa virus may be lower...;such migration furnishes a continuous supply of persons susceptible to Lassa virus infection.

4.2 Governance including policies, marketing systems etc

Is there a tie between the trade-based economy and food insecurity/infectious disease epidemics? Kjekshus (1977) focuses describes the development of centralized colonial government, large-scale forced migration, socio-economic and ecological change, which resulted in ecological problems, food insecurity, and infectious disease epidemics. Kjekshus (1977: 132) illustrates this interrelationship of these catastrophes after the cattle epidemic, Rinderpest:

The Rinderpest marked the beginning of a series of natural and man-made calamities that struck East Africa in the next two decades. Smallpox epidemics, the sand-flea (jiggers) plague, famine and sleeping sickness all occurred within a few years of the great Rinderpest; their exceptional toll was probably linked to this initial weakening of the population. One tragedy reinforced the effect of the other and they were probably all seen by the contemporary Africans as the result of European machinations. 'Nothing was more natural', wrote Rehse from Kiziba, 'than to blame all these calamities on the coming of the Europeans'

What specifically could have led to these calamities? Kjekshus (1977). explains that most known witnesses "clearly judged overseas trade as a negative factor and saw a direct connection between the decline of local industrial initiatives and the increasing flow from the coast" He goes on to state that the perception was that this colonial trading network wiped out the "old integrated trading network" and proceeded to undermine the "industrial supports of the local economy"(Kjekshus, 1977: 125). The restructuring of land use, the economy, and social organization had been conducted for the benefit of the coloniser's economy. This led to a dramatic increase in cattle populations as well as cultivation for crops destined for the European marketplace.(Kjekshus, 1977: 112-160)

This connection of deterioration of ecological and human health and expansive trade-based societies is certainly not limited to parts of Africa. There has been much research observing this phenomenon more widely. For instance, wealthy societies impact on the health and ecological sustainability was illustrated on the World Health Organization's publication, *Ecosystems and Human Well-Being: Health Synthesis: A Report of the Millennium Ecosystem Assessment*, "Historically, overexploitation of ecosystem services has led to the collapse of some societies"(Corvalan *et al.*, 2005: 12). It continues, "There is an observable tendency for powerful and wealthy societies eventually to overexploit, damage and even destroy their natural environmental support base" (Corvalan *et al.*, 2005: 12). The gaining of wealth has been obtained through the rapid exploitation of resources throughout history. However, humans have only been hoarders of wealth in the last 10,000 to 15,000 years, which, according to most

investigations into the past, has also been a time of unprecedented fluctuations in population and ecological crises. Pollen evidence of pre-civilised peoples points to an association of increased ecological complexity and diversity with human occupation (Bradshaw, 2013). This human tie to ecological sustainability and resilience has its benefits. The WHO report notes: “Ecosystems are the planet’s life-support systems – for the human species and for all other forms of life. Human biology has a fundamental need for food, water, clean air, shelter and relative climatic constancy. Other health benefits include those derived from having a complement of species, intact watersheds, climate regulation and genetic diversity. Stresses on freshwater sources, food-producing systems and climatic regulation could cause major adverse health impacts (*high certainty*)” (Corvalan *et al.*, 2005: 1).

4.3 Environmental/natural resources and weather/climate

The need for natural resources for wealth generation often conflicts with the needs of people in the regions where these resources have been taken from or where larger-scale industrialisation has been occurring. Local or national traditions have been quickly dismissed as people depend upon the global trading economy for their living. No other choice has been seen as weak and inexperienced governments have not been well equipped to protect their people from over-exploiting individuals, organisations, or firms, even when that seems to be their aim.

It is difficult to re-structure a government that was not established to be sensitive to local observations and needs. Thus, the centralization of power of the colonial period continued into the post-colonial period. Therefore, even the most essential resources have not been protected since colonial times, as Beinart (2000: 272) explains,

Environmental decay is discussed in many studies of the partial displacement, or compression, of African societies into smaller areas of land as a result of settler colonialism from the Cape to Kenya. Water, the staff of life in more arid zones, was also directly appropriated. In South Africa, settler farms were often named after the captured fountains—Grootfontein, Brakfontein, Modderfontein---which initially sustained

them. By the mid-eighteenth century, as the trekboers moved into the dry interior of South Africa, nearly 50 percent of the new farm names were water-related.

This policy of resource exploitation also effected settlement patterns in order to more efficiently exploit the land, whether it was agricultural cultivation or mining. However, these areas of higher population densities in combination with erratic deforestation and clearance (i.e. for surface mining or cash crop agriculture) would increase the risk for epidemics. Beinart (2000) exemplifies these risks established during colonialism with the expansion of the Ngoni of southern Africa, "Colonial policies which curtailed hunting, encouraged concentrated village settlement and stimulated labour migration exacerbated the effects of the nineteenth-century Ngoni invasion by expanding the area dominated by bush, wildlife and tse-tse"(Beinart, 2000: 272).

The area dominated by "bush, wildlife and tse-tse" were deforested and cleared areas earlier, which under the instability of the *mfecane* (Ngoni) invasion, were left to grow untended. It should also be noted that academic research focused on how these colonies could be successful as part of this international trading system, rather than questioning the system itself. Therefore, scientific studies would focus on particular problems out of their contexts and make suggestions accordingly.

Environmental regulation was certainly sometimes used to curtail African cash cropping but in general was not seen to undermine colonial development, but to facilitate it. Such analyses emphasize the broader context of international scientific developments, and the history of ideas, as well as the particular economic and political conjunctures which gave them salience and power. The discipline of Ecology, elaborated in the early twentieth century, which increasingly informed understandings of environmental change and intervention, owed a good deal to the global imperial context.(Beinart, 2000: 273)

There are many examples of scientific studies (often somehow attached to economic growth with a few particular benefactors) that led to devastating consequences in colonial lands (Beinart, 2000: 272) (though no place is immune to these). The lack of respect for local knowledge and observations may certainly be part of this problem. However, it should be noted that western

science helps promote the international trading economy that is increasingly depended upon.

...the bureaucratic imposition of uniform standards and measures has been indispensable for the metamorphosis of local skills into generally valid scientific knowledge. Science as we know it depends on the administration of nature, a stunning social achievement.(Porter, 1996: 21-22)

Since the identification and control of variables is central to the accuracy of the scientific method, efforts are made to limit variables. This method has questionable accuracy in the uncontrolled ecological context, but is ideal for technological development. Knowledge systems are developed to support the economy that people depend upon, and technological development is the engine of wealth and economic growth in our globalised trading economy.

Least of all can economists afford to ignore innovation, as essential condition of economic progress and a critical element in the competitive struggle of enterprises and of nation-states. In rejecting modern technology, Simone de Beauvoir was consistent in her deliberate preference for poverty.(Freeman and Soete, 1997: 1-2)

The international trade-based economy considers poverty as the lack of assets that have a substantial monetary value. However, this is very different from the goal of the subsistence economy, which is achieved by not taking more than the system can replenish. Generating short-term wealth surpluses in a subsistence economy would be thought of as a quick and dangerous route to poverty and vulnerability.

4.4 The Tanzanian Example: War, Colonialism, Migration, & Natural Resource Extraction

Coastal Tanzania had a long history of outside influences and colonialism, particularly from Arabia. However, the intensity of this colonialism was less than that of the Europeans. Prior to European colonisation inland parts of East Africa were less trade-based and more traditional than the coastal areas. Therefore, the rapid socio-economic changes that took place in the late 19th century were especially dramatic. The newly colonised areas were subsistence economies tied within a complimentary cultural geography, where local

languages were tailored to the ecologies that they inhabited, based-upon pre-colonial times.

The internal lands in Tanzania before colonialism were based in informal institutions that enculturated people in local norms, values, cultures and beliefs, which were rooted within the ecologies they depended upon. Iliffe (1979;9-10) illustrates this in describing the pre-colonial identity of the Tanzanian people in stating, "Identification was "totally relative to the spatial position of the speaker' By moving his home and adaption to a new environment a man changed his identity" Iliffe (1979) follows with the example of the "Shambaa (which means 'where bananas thrive') who left the mountains commonly ceased to be Shambaa"

The pre-colonial subsistence economies were tied to the characteristics of the local ecosystems. The crops produced before colonial times included sorghum and millet, as well as native pulses to Africa. Slash and burn agriculture was used in addition to the use of brush fires to expand grasslands and open savannahs. These brush fires were "...intended to maximize habitat diversity both in the grassland and woody components of the vegetation, "(Trollope, Trollope, and Hartnett 2002: 14). Pastoralists as the Maasai have used fire to develop grasslands and savannah for millennia, which transformed the East African landscape, as Nelson (2012, 2-3) explains,

The ways that local pastoralist communities manage their lands and resources thereby have a major impact on the conservation of wildlife in savannah ecosystems in northern Tanzania. Indeed, pastoralist land management practices such as grazing and the use of fire have had a major influence over the course of the past 3,000 to 4,000 years in shaping East African savannah landscapes. Many observers attribute the contemporary abundance of wildlife in East Africa to the historic influences of pastoralists on savannah landscapes and on the general ecological compatibility between pastoralists and wild large mammals."

In addition to slash and burn agriculture and herding, hunting was also common for many East Africans, as well as iron smelting, which dates back to 500-1000BC. (Childs and Killick, 1993: 320) Regarding disease, many diseases existed before colonialism of the internal lands of Tanzania and continued during

colonial times. Infectious disease associated with malnutrition including polio, typhoid, cholera, tuberculosis (TB), whooping cough, influenza, measles, malaria, schistosomiasis and sleeping sickness. Africans considered disease as a sign of profound social and moral issues in society (Neerinckx, Bertherat, & Leirs, 2010; Msita 2003).

There have been historical discrepancies regarding the extent of tribal wars and if these had much effect on migration patterns before the German colonization of East Africa. However, it is clear there were waves of forced migration into East Africa due to the colonization of South Africa. The Zulu Wars created instability in the region and led to people being pushed out of their homelands. This was said to have caused violent reverberations of the *mfecane* (the Wangoni, Wangwangwara, and possibly other tribal peoples that imitated Ngoni warfare techniques) on a push into East Africa. It has been argued that some tribes had a long tradition of being ruthless raiders and that their economies depended upon this for their survival (Kjekshus, 1977: 12-20). This raiding has been said to have a dramatic impact on the population levels in East Africa. However, it is difficult to imagine how a 'raiding economy' could be sustained over a long period. Raiding as a means of sustenance while living in the same general geographic area, would be restricted to taking resources from their neighbours. Certainly, the neighbours would be more prepared for raiding over time, and this would have an increasingly dangerous method of maintaining an economy over time. Repeated raiding by one tribe would encourage others to align against them. It is difficult to see a raiding-based economy functioning over generations. That said, it is plausible that raiding was a political act which supplemented the economy of those that were more mobile (i.e herding peoples). This could be important to get through periods of poor years for hunting-gathering, small-scale agriculture, or a lack of access to pastoral areas for cattle, during this period of fluctuating migration, settlement and land use (and destruction, i.e. the scorched earth policy done under German occupation). Burton traveling through East Africa in the late 1850s below illustrates his belief that large-scale deaths from raids was not likely:

Even the bravest East African, though, like all men, a combative entity, has valour tempered by discretion and cooled by a high development of cautiousness. His tactics are of Fabian order: he loves surprises and safe ambushes; and in common fraud and forays the loss of one per cent justifies a *saube qui peut*. (Burton, 1859: 331)

The instability of Africa dramatically increased with colonization, while European military training was more successful in conditioning and equipping people for mass slaughter (Grossman and Christensen, 2007). Thus, extrapolating what was the norm from this small sample (which has often been done) cannot be considered accurate, and maybe more to do with colonial stereotyping of indigenous peoples as savages. It is only with the establishment of wealth surpluses that long, sustained attacks could take place. Western weaponry is much more lethal and quicker, but the only way these weapons could be had were through a substantial wealth surplus.

With European colonisation the rate of raiding for slaves and the slave trade dramatically increased (Kjekshus 1977: 21). According to Kjekshus (1977) , a new demographic hypothesis suggests pre-colonisation of East Africa had slow-growth/stability with a debatable period in the early nineteenth century with the reverberations of war in South Africa. This resulted in displaced populations migrating northwards, which led to conflicts in Tanganyika. Based on the ecological and historical evidence, Kjekshus (1977) believed there was no population decline before colonialism in 19th century East Africa (Kjekshus, 1977: 21-24). However, post-colonial population decline is well-documented. The war with Germany during its 'pacification' policy resulted in many deaths from the sustained military conflict as well as food scarcity due to the scorched earth policy. The subsequent establishment of agricultural expansion and the subsequent lack of pastoral land resulted in cattle being stall-feed (i.e. the Chagga peoples) (Kjekshus, 1977: 34-36) and others becoming cash croppers (as the Waddigo) (Kjekshus, 1977: 33-34) or became hunter-gatherers as the tse-tse fly wiped out their herds (as the Wakimbu) (Kjekshus 1977: 64-65). The lack of land forced many cattle-herding tribes to take risks where the tse-tse flies were known to have been active:

According to German records, the Waluguru before the War had 4,500 head of cattle but they have all gone though I am not sure what happened to them...Increasing cultivation above forced the cattle to graze always lower down the slopes until they were killed off by tse-tse fly... (Kjekshus, 1977: 61)

After colonisation, the increased dependency upon a trade-based economy resulted in many changes. Trade itself became less efficient as the traditional markets did not have the middlemen and was not profit driven. Rather the interconnectedness and mutual dependency of people at the marketplace diminished their vulnerability. Trade was conducted within a nexus of social relationships. Good faith and will helped establish networks that could be counted on, and gift-giving served as investments in people's own future. Western-style international trade rewarded insincerity due to the lack of a mutually dependent, personal relationships. Trade increasingly took place between unidentifiable sellers of commodities and unidentifiable buyers in a far-away country. Thus, insecurity of the marketplace increased alongside greater inefficiency in food distribution. (Kjekshus, 1977: 113-114)

Since much of the food was going to faraway lands, rather than being consumed within Tanzania, more food had to be produced for people to make ends meet. This meant greater deforestation and clearance of fields, while herd sizes also increased as demand for overseas meat heightened. Therefore, as cultivation expanded, there were fewer areas for domesticated animals to graze. Thus, as former forest areas were opened up, cattle and other domesticated animals were grazing there. However, many of these areas were where the tse-tse fly lived.

The Makalolo are people from infancy accustomed to tend cattle, possessing a thorough knowledge of the most fattening postures to be sought, and noxious herbs to be avoided...They have learnt that these deadly places may be crossed with safety by night if sufficiently narrow to allow the cattle being driven through before sunrise. (Kirk ,1865: 153-154)

The local knowledge of regional vegetation, animal and insect life and the attributes, characteristics, and hazards of these environments were crucial for sustainable herding. However, due to the rapid anthropogenic changes of many ecosystems and the high level of forced and voluntary migration, many people

were not familiar with the ecological characteristics of the areas that they found themselves in. Also, ecosystems were changing, as hunting was increased both for sport (for Westerners) as well as to diminish threats to local agricultural settlements. This was thought to have led to the increased prevalence of the tse-tse fly, as potential blood hosts and predators, diminished in population (Kjekshus, 1977: 69-78). This in combination with people living closer to their livestock herds, which were closer to tse-tse areas, lead to an increasing problem as colonization expanded under British rule.

Early British administration in Tanganyika coincided with a number of serious sleeping-sickness epidemics in Maswa, Kigoma, Liwale, and Rukwa(AMR 1924:44)...The research undertaken by Wietz and Glasgow (1956) and Weitz (1963) has fully established the feeding dependence of the tse-tse fly on certain well-defined species of wildlife such as antelopes, buffaloes, warthogs and bushpigs. Ashcroft (1959a) has reviewed the incidence of trypanosomes in the animal hosts and further sharpened the understanding of specific species of wildlife as permanent reservoirs of trypanosomiasis. If such game species disappear, so does the tse-tse. Wölf (1911) made this observation connection with the Rinderpest and the disappearance of the tse-tse fly in Uha and western Unyamwezi. Potts and Jackson (1952) reported the complete disappearance of *Glossina* following an experiment of controlled game-destruction in Shinyanga. (Kjekshus, 1977: 69)

Wölf's observation that the tse-tse disappeared after the lack of mammals for the tse-tse to use as blood hosts is plausible. Burton substantiates the dramatic decline of animal life in his observations to 1860 in Tanzania. He states the techniques of grass burning and organised hunting was largely responsible for the lack of animals. He elaborated, "for the scarcity of animal life so remarkable in this animals' paradise." He continued: "In the more populous parts game has melted away before the woodman's axe and the hunters' arrows: even where large tracks of jungle abound with water and forage, the note of a bird rarely strikes the air, and during a long day's march not a single large animal will be seen from the beaten track"(Burton, 1859: 268; Kjekshus, 1977: 69).

III. The Tanzanian Example: The Development of Zoonotic Epidemics

4.5 As Wildlife Decline, Desperate Parasites use Cattle and Humans Available as Hosts

Host availability seems to have led to a change in what the tse-tse fly depended upon, less on wildlife and increasingly on cattle and then people in close proximity. However, in areas with domesticated animals, as cattle, these animals became the blood hosts of the tse-tse, and the parasites would then infect the livestock. My experience in the Hok Tek T'oi Wichi community in northwest Argentina showed a similar situation with the vinchuga beetle (which is known to carry the parasite that causes the Chagas disease). The wildlife was wiped out by massive flooding (even Wichi people had to be saved by helicopter (Palmer 2008)²⁵) after large-scale deforestation and soy plantations were established. Subsequently, according to Roque, the eldest of the community, there was a great manifestation of the vinchuga beetle that was not present before. Similar to Burton's observation above, I saw very few birds and no animals. However, the vinchuga beetles were saturating the community. A medical anthropologist called them "domesticated", as they were a larger and slower variety than would be seen in the wild. Also, when I walked away from the community settlement area into a light wooded area I saw very few vinchuga beetles. I had the same observation in the city, Tartagal, which was just 20-25 km away.

Therefore, it seemed that the cleared areas forested regions were especially at risk. Larger cleared areas may have had less risk in East Africa as the tse-tse was still part of the forest ecology. Thus, as deforested and cleared areas were allowed to grow back, the expansion of the tse-tse fly grew dramatically. The diversity that would be seen in an established forest was not seen in these re-growth areas, and even the established forest ecosystems were simplified due to the diminished wildlife (and potential tse-tse fly hosts). These re-growth areas would also lead the tse-tse fly right up to cattle grazing areas and settlements, leading the fly to two potential hosts, people and cattle.

Cattle dependency in East Africa was very high not only for herders, but also agriculturalists as cattle are used to plough and fertilise fields. Therefore, the tse-tse epidemic on cattle, as well as the sleeping sickness the fly transmitted to

people, had a great impact on the people. However, the future was to get worse with the Rinderpest epidemic, which took the lives of the majority of cattle in East Africa in the last decade or so of the 19th century. The immune systems of cattle were compromised by the tse-tse fly, and their diet was frequently suffering as ecologies were changing and herds were often moving to new areas that herders were less familiar with. Herds increased as the commercial industry and market for beef was growing. However, the expansion in the number of cattle came from the same amount of established species. Therefore, a relative decrease in biological diversity had occurred, increasing the chances for disease to be transmitted from one animal to the next. Since the immune system responses would be similar within the same species, it increases the chances for a pathogen to adapt and thrive, due to the lack of species variety. Consequently, after most cattle died of Rinderpest, many fields were not ploughed and there probably was a shortage of fertilizer. The scenario can be mapped out that people over-cultivated smaller fields as their ploughing and fertilizing potential diminished. This would have led to less soil fertility and poorer yields, resulting in malnutrition. Thus, less healthy people would have to work intensely in the fields for less and less food. Since cash-crop agriculture requires many labourers, new mothers would have to work in the fields and wean their babies quickly, weakening their infants' immune systems. This would be happening while the formerly cleared lands regrew around communities, thus increasing exposure of their livestock to the tse-tse fly, while their own immune systems had been weakening due to long labour hours and probable malnutrition. Problems in nutrition would have stemmed from the lack of ploughed fields to sow seeds, and thereby the over-intensive farming that took place on the ones they possessed. This would have over-exhausted the soil of its nutrients as well as the increasing the risks of wind and water erosion.(Kimaro *et al.* , 2005: 97-108; Mwango *et al.* ,2014: 18-28; Tully, Sullivan, Weil and Sanchez, 2015)

4.6 Possible explanation of increased risk of famine and an epidemic on agricultural lands

Intensive Agriculture & Forestry & the Market Economy

This chart illustrates a potential danger that may be related to tilled/ploughed soils.

Hypothesis of Deforestation and Cultivation Leading to Increased Wetness

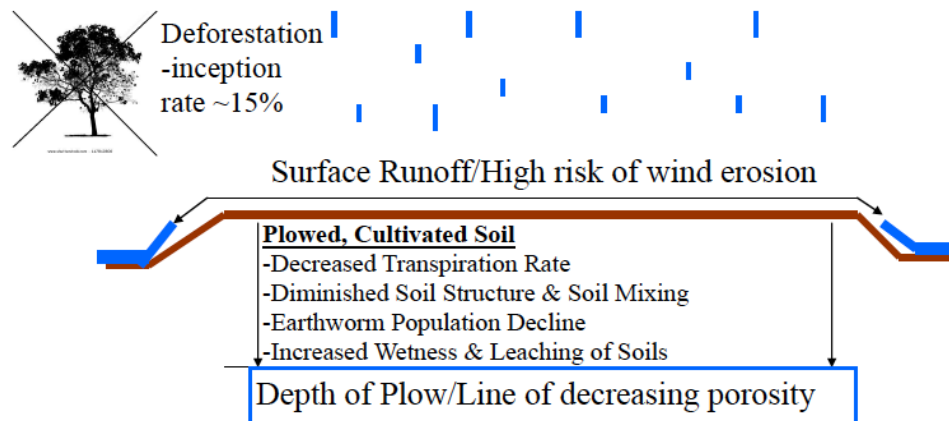


Fig.4.1. The diagram shows a potential process of diminished fertility for larger-scale cash-crop agriculture.

The depth of the plough line is increasingly reinforced through repeated tillage/ploughing at the same depth. Thus, the porosity past this increasingly packed and hardened area decreases over time, leading to increased wetness above the plough line. These ploughed soils are broken down and subsequently have a diminished structure, which absorbs more water. The results are soils that are increasingly leached of nutrients, leading to diminished crop yields. Additionally, ploughing has been shown to decrease the presence of earthworms, which are also tied to soil fertility and higher crop yields (Cunningham, Collins and Cummins, 2001: 172-175; Cunningham, Farrell and Collins, 1999: 63-76).

There is also a potential connection here to rodent burrows, pathogens as *Y.pestis*, and ploughed soils. Formerly ploughed soils have been tied to a greater presence of rodent burrows (Meliyo *et al.* 2015: 105-119), while burrows of high densities are highly correlated to bubonic plague infection rates of the rodents and subsequently humans.

A Scenario of *Y.pestis* survival outside of Human Populations

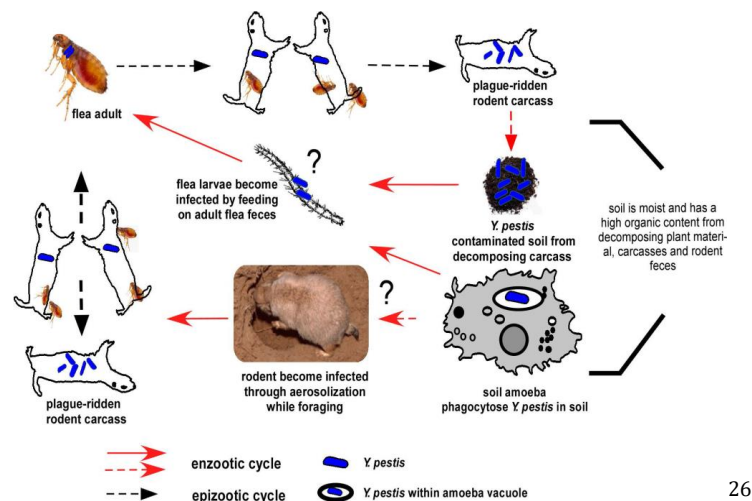


Fig.4.2. Benavides-Montaño, J.A. and Vadyvaloo, V (2017:40) example scenario of how *Y.pestis* survives when a Plague epidemic is not present in human populations.

Benavides-Montaño, J.A. and Vadyvaloo, V (2017) above illustrates a scenario of the creation of an *Y.pestis* reservoir where multiple factors come into play, including fleas, rodents, the soil, soil amoeba, as well as the moisture in the soil. There is a school of thought that *Y-pestis*, which can live at least a few months in cultivated soils (Laudisoit 2013) (compared to much less in forest soils), may have soil reservoirs. If that is the case, then it should be noted that ploughed soils may have diminished defences due to the decrease in mycorrhizal fungi networks, which are anti-bacterial and give nutrients to plant-life. The soil structure of unploughed soils would pose a greater barrier for pathogens to pass through compared to the potentially water-logged soils, which would help the transportation of these single-celled organisms. The hypothesis that soils act as a reservoir for pathogens is linked to the level of vulnerability associated with anthropogenic impacts of deforestation and cultivation.

As colonization progressed, so did the environmental impact. These changes increased the risk for an infectious disease epidemic, as populations moved and increasingly settled in different areas, and altered the ecologies they lived around. Referring back to McMichael's, Laudisoit's (2007) and Begon's (2013) vulnerabilities of an infectious disease epidemic, it is quite apparent that the risks were increasing here. As McMichael noted as risk factors, we see an altered

habitat, with biodiversity change and habitat fragmentation. Brearley *et al.* (2013: 427) explain,

Human-induced landscape change is increasingly recognized as impacting the health and fitness of animals in habitat fragments. Habitat loss and fragmentation reduce the amount and connectivity of suitable habitats. This affects population viability, lowers genetic diversity and causes inbreeding depression, potentially making individuals more susceptible to existing or novel diseases and stochastic environmental events. The contribution of infectious disease to the decline of susceptible wildlife populations may increase as the quantity and quality of suitable habitat declines.

This rapid anthropogenic change from diverse forested areas to cleared pastoral and cultivated lands, to re-growth areas with a lack of wild animals. This may have led to what McMichael called ecosystem imbalance as potential predators (i.e. birds) decreased in relation to potential host species (i.e. cattle and people). The intensified farming and animal husbandry (also a risk factor) would have given the tse-tse fly with the hosts it needed to thrive in being a close proximity to cattle and people. McMichael's factor of a niche invasion (that is resulting from a new or recently vacated niche) can be seen in the re-growth areas for the tse-tse fly. These areas would have provided the insect with an ideal environment to thrive with limited competition. McMichael's last factor (2004), human induced climate change could have been seen on a micro-level. Deforestation would have diminished the presence of a deep forest shade, and cleared areas would have increased the evaporation rate. It is also plausible that ploughed soils would have increased this effect (See chart in footnote 120). This potentially could affect regional precipitation and humidity levels. Deforestation and clearance are also keys to some of LaDisait's (2007) risk factors for a zoonotic epidemic. Increases in forests edges are developed by deforestation creating smaller forest fragments and "a greater interface between humans and fauna and the zoonotic pathogens they carry. Darmon *et al* (2014) observed that mice abundance especially increased with cutblocks (thinning forest tree density rather than deforesting an area) (Darmon *et al*, 2014:322). LaDisait (2007) also notes that the trading of forest products and bush meat, as well as encroachment into the forests, augment vulnerability of a human

zoonotic. The encroachment in the forest for fire wood has been also tied to greater plague outbreaks (Hubeau *et al.*, 2014: 11).

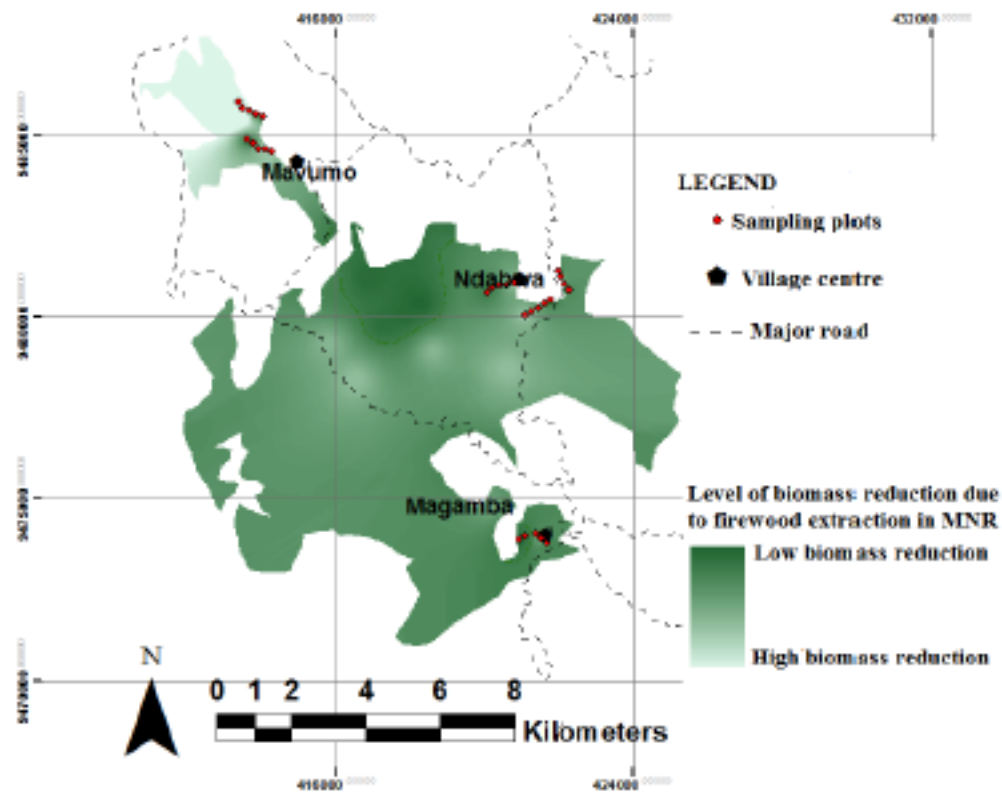


Fig.4.3. Spatial distribution of biomass change due to firewood collection in the Magamba Nature Reserve, Lushoto, Tanzania (2009-2013). Mwabumba (2015:28) demonstrates in this example that the small fractured forest by Mavumo is frequently being sourced for firewood as is the forest by Nbadwa. The percentage of human activities that included firewood collection in Mavumo was 22% verses 27% in Nubawa. (Mwabumba, 2015: 22) However, the plague frequency observed by Hubeau *et al.* (2014) was 0.611 for Mavumo and 0.278 in Nbadwa, which may in part be due to the small fractured size of the forest Mabumo.

Clearance of vegetation is also seen as a risk factor as land use changes and conversion of the land to agriculture leads to different vegetation and thus, niches being created (Ceradini,. and Chalfoun, 2017: 1823). Wood and Singleton (1994) noted that “higher lands of eastern Africa, the dominant cash and food crop is maize, which is subject to heavy rodent attack.” They also explained that “Other cereals, legumes, tomatoes, root crops and cash crops like cotton and sugarcane also can be damaged”(Wood and Singleton, 1994: 45) Thus, the

introduction of crops develops a new niche that some rodent species take advantage of and creates a disturbance of interactions between species that often include domesticated animals, causing species range shifts. Additionally, animal husbandry creates increased contacts with domestic animals and humans. Many studies, particularly around the Tibetan Plateau, which is believed to be the origin of modern-day plague strains, have shown a tie between intensive livestock grazing and feeding areas and the augmentation of some rodent populations (Bueno *et al.*, 2012: 22; Cincotta, Zhang & Zhou, 1992: 3–25; Davidson *et al.*, 2010: 3189; Duplantier and Rakotondravony, 1999: 452; Jones and Longland, 1999: 1; Ronkin, Savchenko and Tokarsky, 2009: 282–4; Shi, 1983: 181–187; Smith and Foggin, 1999: 238; Zhong, Zhou & Sun, 1985: 241–249). Duplantier and Rakotondravony (1999) observed this phenomenon in cattle pens during the human plague in Madagascar,

The beginning of the human plague season in the highlands (November) coincides with the minimum abundance of rats outside houses and the annual maximum abundance of fleas. We have shown that particular habitats seem to be important for transmission; i.e. the sisal fences around the cattle pens, situated inside or on the edge of villages. These are where the rodents and the fleas are most abundant, and it is also where the highest antibody seroprevalence against *Y. pestis* was noted among rats. (Duplantier and Rakotondravony, 1999: 452)

Additionally, settled agriculture typically brings with it higher population growth as many labour hands are needed. These population increases near recently cleared forests is especially hazardous.

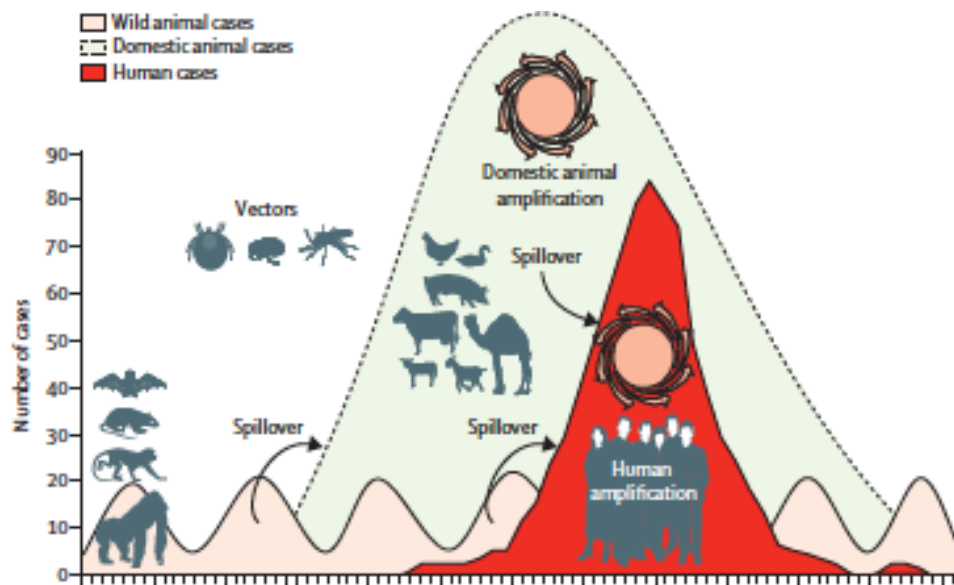


Fig.4.4. Disease Ecology –Transmission Diagram. Karesh, *et al.* (2012: 1942) illustrate the common routes of transmission of zoonotic disease in human populations. They explain the diagram of a transmission of zoonosis disease “of infection and amplification in people (bright red) occurs after a pathogen from wild animals (pink) moves into livestock to cause an outbreak (light green) that amplifies the capacity for pathogen transmission to people”.

Karesh et al. (2012) illustrate how the increased contact of wild animals with domestic animals heighten the risk of a human zoonotic disease epidemic. Much like Laudisoit (2017), Begon (2013) focuses on this transmission from animal populations in the wild. Begon’s risk factors for an epidemic include an emerging infectious disease in wildlife, which really would be speculative to of the late 19th century East Africa. However, his second point, the increased interaction of area wildlife with humans can be noted as people’s domesticated cattle seemingly became the main host species of the tse-tse fly in some areas. Begon’s (2013) factor of increased human vulnerability to infectious disease may be seen as risks for malnutrition were on the increase. Beyond the German impact of ‘pacification’ was the increased burden to create large surpluses for taxes and enough cash from cash-cropping to make a living from. Greater migration also meant looser networks, and German organised trade had middlemen and were less efficient with food distribution than the traditional East African women’s markets (Kjekshus, 1977: 113-114). Additionally, the increased dependency on cereals may signal a decrease in immune system

vitality (Pellett, 1996; Cordain, 1999). Begon's last factor (2013), the increase in human population densities and movement within and among different populations, which increase the chances of human to human infectious disease transmissions, is certainly present. As cash-cropping and large-scale herding developed as commercial enterprises, so did the intensity of labour that these industries required. Thus, larger settlements and labour camps of migrants became increasingly present and experienced greater population densities. Decken in 1869 (184-85) observes:

In the middle of the forest there were often large clearings with extensive settlements (*Ortshcafen*); not real villages (*Döfer*) in our sense, but widely extended cultivations and huts. On the well watered (west) side of Ruhuhu (uhuu) River, the roads would now and then lead through fields and huts over distances that it took as much as two hours to pass through.

These vulnerability factors shown here to be apparent in the late 19th century form the foundation for subsequent and greater risks of other infectious disease epidemics in the future. As mentioned earlier, many infectious disease follow rinderpest, which followed the epidemic of the tse-tse fly. There were also others, such as the red locusts. These were different parasites that were not as devastating, but nevertheless directly or indirectly weakened people's resiliency to fight off an infectious disease epidemic.

Moving further forward in Tanzania's past, not only will these vulnerability factors for an infectious disease epidemic become more apparent, but so will Tainter's factors (1988) leading to organizational collapse and Van der Leeuw's (2009) organizational factors leading to an ecological crisis. The colonial socio-economic system had been set-up for individual entrepreneurship, but Tanzania's first president, Nyerere inherited the British system that was, for instance, encouraging entrepreneurial cash-cropping, of tobacco and other crops for external marketplaces.

From 1951 to 1962 a handful of settlement schemes were started by the Tanganyika Agricultural Corporation and the East African Tobacco Company with the central object of promoting small holder commercial production of tobacco. These were not resettlement schemes but new

settlements based on the principles of individual entrepreneurship. (Shao, 1986: 222)

It was a difficult task to have successful entrepreneurs to move from what they were making a substantial profit on. An example of this success was the tobacco farmers in the Urambo scheme in the Tabora region, which by 1963 had 761 farmers that produced 176, 000 pounds of tobacco worth about \$60,000,000 (Scheffler, 1968: 279). This programme to convince farmers to grow tobacco was very successful. However, it is well established that tobacco rapidly diminishes soil fertility. The World Health Organisation's Tobacco Free Initiative (TFI) states: "In many tobacco growing countries, evidence indicates irreparable environmental damage from tobacco agriculture particularly when associated with the deforestation necessary to increase farmland for tobacco plants." The June 1995 Bellagio statement on tobacco and sustainable development concluded that, in the developing world, "tobacco poses a major challenge, not just to health, but also to environmental sustainability." Tobacco's leaching of soil nutrients may quickly leave soils infertile.

Studies have shown that tobacco absorbs more nitrogen, phosphorus and potassium than other major food and cash crops, and therefore, tobacco growing decreases soil fertility more rapidly than other crops...(Lecours, Almeida, Abdallah, and Novotny, 2012: 192) In Kenya, land under tobacco has also grown in acreage at the expense of food crops...This shift towards tobacco production has made traditional crops such as cassava, millet and sweet potatoes scarce, and has caused reductions in livestock production. (Lecours, Almeida, Abdallah, and Novotny, 2012: 194)

The attractiveness of the relatively high market price certainly led some Tanzanian farmers to grow the crop. However, this is not just a question of growing tobacco instead of another crop. There is also a risk of growing other crops on soils that used to grow tobacco, as the potential loss of soil fertility could lead to poor yields.

4.7 Intensive Migration & Settlement on Marginal Agricultural Lands

The Nyerere government had a difficult time convincing many Tanzanians to abandon their successful entrepreneurial ways that had been enculturated for decades first with German occupation, and then more intensely under British

colonialism. Thus, many successful farmers were refusing to move, and Nyerere used military force to re-settle many Tanzanians. According to Nyerere (1977) over 11million moved from September 1973 to December 1976, almost all of which moved new village communities (Nyerere, 1977: 41-42). The total population of Tanzania at the time was about 16 million. The only farmers that were not moved were “well established perennial crop cultures, particularly coffee and bananas”...(H)owever, even these villages were instituted with “new political and economic structures” (Shao, 1986: 221). The Nyerere government was attempting to reverse the process of entrepreneurship and individualism that some were benefiting from. “The overriding objective of the villagization program was...to prevent the emergence of a class of prosperous farmers and wage workers by preserving and perpetuating the class of small peasant producers” (Shao, 1986: 223). Nyerere’s villagization programme paid little attention to local, traditional knowledge and with the huge (and often forced) migration within the country, this knowledge would have been greatly diminished. Marginal lands were also needed for cultivation and their potential yields greatly overestimated. Families all too often were pushed onto such lands as “permanent cultivation and the development of commercial production, particularly in the more fertile regions, had already led to private ownership of land in fact if not law”(Shao, 1986: 235-236). More fertile lands were occupied by grand commercial enterprises and were not affected by villagization. This meant that most of the Tanzanian population had to migrate to less than ideal lands to sustain a living from. They had to do this with lands and neighbours that they were not familiar with. As Shao explains,

...the existing patterns of settlement and land use had been developed by the farmers after centuries of experience and of careful regard for the natural ecological conditions of their areas...various methods of artificially restoring fertility to the soil had been devised over the centuries, particularly the use of animal manure, mulch, and crop rotation, although these were still supplemented by some fallow cultivation. This restoration accounts for the relatively greater carrying capacity of the land, and hence the denser population, the closer settlements, and the prevalence of the Rungwe pattern of settlement. (Shao, 1986: 223)

Traditionally local people depended upon the local lands for their survival. Therefore, great attention and education was focused upon their local ecology, which their sustainable economies were based upon. Their economies had to be sustainable, or they did not survive. As an adaption to the quickly changing landscape, some cultural economies went back to more traditional, subsistence economies. The Wakimbu, who had their wealth built-up through greater cattle herds, had to change. They may have lost most of their herds through the rinderpest epidemic and subsequent cattle diseases. Thus, as Kjekshus illustrates, the reality they were faced with forced a cultural-economic change: "It would seem that the ecological situation that forced the hunter-gatherer existence on the Wakimbu of today is a twentieth-century phenomenon" (Kjekshus, 1977: 85). However, this goes beyond ecology, as social organization and networks provided much more efficient distribution of food and needed resources compared to colonial and post-colonial periods. Nyerere's centralized government took away local control and diminished community adaptability.

4.8 Refugee Migration of the 1980s and 1990s

During the second half of the 20th century, wars in Uganda, Rwanda and Burundi made Karagwa (as well as other areas of Tanzania) the refuge for numbers of refugees. Particularly during the 1980s and 1990s many refugees arrived from the ruthless civil wars in Rwanda and Brundi. Big refugee camps were opened in Omukaliro, Kyabelisa, Kagenyi and Rwabwere. Most of the Rwandan refugees were returned in the end of the 1990s but many escaped re-patriation and people are still crossing the borders in both directions. This flood of refugees affected Karagwe in many ways. The increase in inhabitants, about 400,000 refugees are estimated to have invaded Karagwe during the 1980s and 1990s, was an extra strain on water and wood resources.(Wedin, 2004)

The refugee camps were dense and insecure places for people escaping from war-torn regions. Additionally, these camps would have had a high risk of people's health being in a vulnerable state, making the chances for infectious diseases to spread particularly high. The insecurity of these camps has led to a general migration movement to higher altitudes, as people felt these areas were more secure (Wedin, 2004). Thus, the colonial and post-colonial periods mark

the period of the highest migration in East Africa ever recorded. The most populous migrations being in the 1970s villagization program and the refugee migration of the 1980s and 1990s. In 1980 the bubonic plague began in the Lushoto District of Tanzania.

IV. Bubonic Plague in Highland Tanzania

4.9 An overview and historical perspective of plague in Tanzania

Plague has been endemic in Tanzania for more than a century. According to available information, the disease was introduced into the country through Uganda and Kenya long before the arrival of European missionaries, administrators and explorers.

Its spread was facilitated by slave and ivory trade caravans which usually started in Uganda and went eastwards through the hinterland of Kenya to Mombasa, and southwards to Tabora and Ujiji, and then across the hinterland of Tanzania to the coast. Some routes ran from northern Tanzania through the Kilimanjaro area to Mombasa. Indeed most of the currently active and quiescent foci of the disease are found along these ancient routes.(Kilonzo, Makundi and Mbise, 1992: 323).

Even though the bubonic plague was first recorded in the late 19th century, many communities had named the disease and put measures to limit its impact well before that time (Kilonzo, Makundi and Mbise, 1992: 324). Though *Y-pestis* was present before European colonization of East Africa, it only reached epidemic proportions since the late 19th century. This also marked the beginning of an intense period of epidemics from the tse-tse fly, to the cattle epidemic, rinderpest, and the start of the Plague:

Between 1886 and 1969 many foci were established in the country. These include the Iringa, Lake Victoria, Singida/Kondoa, Mbulu, Meru, Kilimanjaro and Pare foci. According to Kilonzo (1981), many outbreaks of human plague occurred in these foci during the period 1886-1979 and involved large numbers of human cases and deaths. The author further reported that enzootic plague foci potentially exist at the Lake Rukwa Valley in south-west Tanzania (Chunya focus) and in villages along the Tanzania-Kenya border in Monduli district (Tingatinga focus). Human plague has not been found in these foci but rodents are substantially infected. (Kilonzo, Makundi and Mbise 1992: 324)

The spread of *Y-pestis* and bubonic plague grew to encompass a large area in East Africa from the time of German colonialism, British control, and during the early post-colonial period. During early independence, Tanzania had established British institutions and multinational corporate influences that were largely ran by the same professionals as in the British colonial period. However, the Nyerere government wanted to create a socialist country but still maintain a system to create a wealth surplus that would be shared by all. The Villagization programme moved eleven of the sixteen million people in Tanzania, mostly in the 1970s. This program expanded agriculture into marginal lands and intensified the agricultural areas already established. Villagization along with the refugee camps of the 1980s and 1990s certainly had a big impact on local resources. It was at this time when the bubonic plague developed in the Lushoto district in the Usambara mountains.

The Shume focus in the Western Usambara mountains, Lushoto district, was discovered in 1980 when it experienced the first outbreak of human plague. This outbreak, which involved 49 cases with 11 deaths and which affected 2 villages, was unforeseeable since the district and the region (Tanga Region) as a whole had no history of plague. However, earlier studies suggested that the outbreak originated from southern Kenya where the disease was then prevalent, but possible persistence of an enzootic focus which was inactive for a long period was not ruled out. Whatever the origin however, outbreaks recurred in the area every year by July 1990 a total of 3148 confirmed or suspected cases with 311 (9.9%) recorded deaths had been attributed to the disease while the focus had expanded from two to forty-five villages. (Kilonzo, Makundi and Mbise 1992: 324)

The expansion from 2 to 45 villages shows the lack of effectiveness of control mechanisms. Due to the Villagization process, it is probable that many, if not most people had few if any strong roots in the area that they were settled. Accordingly, the amount of knowledge of the area ecology and potential vulnerabilities may have been limited. Additionally, the lack of established community history would have affected the potential of the people to adapt, as they were just learning about each other and what they would be able to together. The functioning of their interdependency was in its infancy. Therefore, people were probably more dependent upon the government than any time in

East African history (the villages were not self-sufficient and relied on government handouts, though the government ran out of food support in the 1970s) (Shao, 1986: 219-239). Regarding government support to combat the bubonic plague, the widespread use of chemicals, as insecticides, were used, though it was not successful. Kilonzo *et al.* (1992: 324) explains:

Initially, some control measures including rodent and flea killing, chemotherapy, chemoprophylaxis, sanitary improvement and health education were undertaken during and immediately after each outbreak of the disease. Starting in 1983 however, house spraying with 10% DDT was carried out indiscriminately in the affected villages irrespective of disease outbreaks. Since outbreaks continued after applying these measures, a special flea control operation, using the same insecticide, was carried out in April 1987. Despite this undertaking, the disease broke out every year, usually from November to May when the mean ambient temperatures were above 16° C.

The standardization of the control measures without regards to local environments and risk factors may have heightened risks in some locations. For instance, houses spread with 10% DDT, a dangerous poison to humans, may have lowered people's immune system effectiveness. Additionally, the months of relative warmth above 16° C in highland Tanzania are important to note as the outbreak period. Micro-climates may have played a role here, as large, deforested areas have a significantly warmer ground temperature. This is especially true for the soil temperature, which is important since the most frequently cited association among modern plague epidemics is a high population density in rodent burrows.

4.10 Land use and microclimate-plague relationship

In the western Usambara Mountains, Tanzania, there is a relationship between the plague disease and the activity of firewood collection. One of the explanation can be the regular land use changes in plantation; plantations are harvested in cycles. The cycle of harvesting has as result a periodic of higher accessibility into the plantation and therefore a higher contact frequency between human and vectors. Moreover it induces habitat fragmentation, which can change the ecology of vectors. Previous studies confirms that biological factors, such as suitable rodent reservoirs, efficient flea vectors, and plague bacillus as

parameters responsible for plague outbreaks in west Usambara Mountains (Lushoto district).

West Usambara Mountains, Tanzania- Burrow Sampling & Presence of Bubonic Plague ²⁷

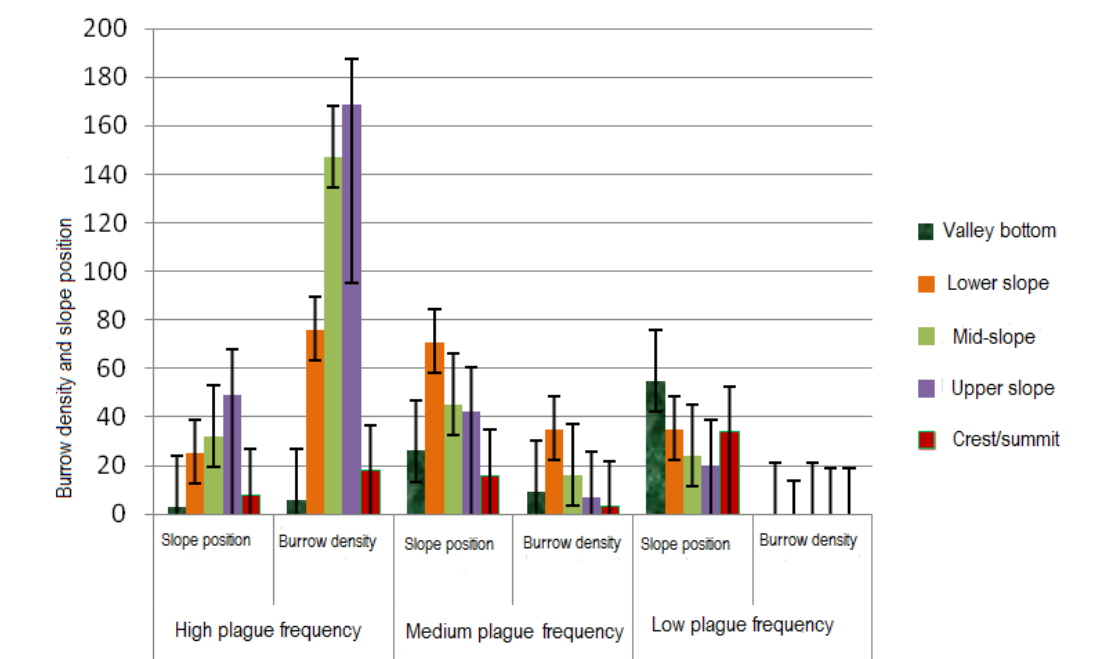


Fig.4.5. Meliyo’s chart (2014:6) illustrating the correlation of Plague frequency with rodent burrow density and the altitude position of the burrows on the slopes.

Rodents have also been known to be attracted to warmer areas, which deforested and cleared areas would be relatively warm (0.5-2 degrees Celsius) (Parker Atinmo and Titanji, 2007: 5). However, anthropogenic activity that diminishes vegetation diversity has been seen to decrease the diversity of small mammals (Ralaizafisoloarivony *et al.*, 2014: 9). There has been a tie to anthropogenic activity in the landscape, in general and the Plague and larger scale, western style agriculture specifically. Looser, formally ploughed soils have been thought to be easier for rodents to burrow. Additionally, high altitudes have been cited as a significant for bubonic plague outbreaks (Laudisoit *et al.*

2007: 687). Thus, it seems bubonic plague is more of a temperate climate disease and relatively rare in tropical climates.

Below are two pictures where the bubonic plague was especially present.



10



11

Fig. 4.6 & 4.7. The two photos are of a cash crop area in Lushoto, Tanzania that was an epicentre of bubonic plague, note deforested areas around fields, which were had the greatest prevalence of overpopulated rodent burrows that are believed to spread *Y.pestis*. Note the limited potential & adaptability of this western-style agricultural system to deal with a change in climate/precipitation, insects/pests, crop disease in order to be able to meet the high demanded output needed by the population. Photos taken in the Lokome-Shume area of the Lushoto District, Tanzania during an excursion of the LEPUS Conference Soils, Land Use And Plague.

These cultivated areas lack biological diversity, while the soils, which are ploughed and typically have the same fertility or decomposing mater giving them nutrients, are also simplified systems. Additionally, annual ploughing at the same depth may lead to an increasingly impermeable layer at the depth of the plough. This may limit the water passing through this layer, resulting in wetter soil above it, leading to leaching of soil nutrients. Cleared fields have also been cited for high rates of wind and water erosion. Ploughed soil have also been shown to have fewer earthworms and a lack of fungus networks, which are essential for trees/larger plant-life in less than adequate soil fertility. The simplified systems in the biosphere as well as in the soil diminish their potential defences. Therefore, it is easier for an opportunistic species to dominate a niche,

as well as the parasite that depends upon them. Compare the two previous pictures with the third picture (below) of a forested area with the outdoor altar with a tree in the middle of it. This last one had no bubonic plague, but both of these locations are in close proximity to each other.



Fig.4.8. Site of Late Nineteenth Century German Missionary and Regional Home of the Shambala People

Site of missionary in 1891 during German colonisation & home to the Shambala people, the most traditional area of the excursion area. Note potential & adaptability of the system in sustainably expanding ecosystem services needed by a population. Photo taken in the Lokome-Shume area of the Lushoto District, Tanzania during an excursion of the LEPUS Conference Soils, Land Use And Plague.

This site is atop a forested hill that has been established by a missionary in 1891 during German colonization. According to the Conference Excursion Guide,

The Mlalo basin is source of water for a number of settlements. The area is remarkable by its lush vegetation, and for a number of horticultural products.

The Shambala people have lived in this region from around 1500. Since about 1820 the Germans have established one of their headquarters here. But the fame of Mlalo started with the Lutheran missionaries coming from Tanga in 1891.

The area is rich in history of the Shambala people, the colonial period, the entry of Christianity, and a number of historical buildings and sites.(LEPUS 2013: 25)

This site had much deeper ancestral roots than others, which had all been post-18th century settlements. This site is also significant as the outbreaks on the eastern side of this region, closer to this missionary site, did not have the large outbreaks that were seen in the western part of the region.

The missionary is of German Lutheran origin, in the North-Eastern diocese of Tanzania. Lemmi Tamilwai Baruti recently focused on the missionary and the practice of ancestor veneration that has been common place since the religious institution had been established there. Baruti notes how profound the attention to ancestors has been here, noting:

Having been into spiritual existence, the living dead acquire special power and more responsibilities from the society they were physically living in. Ancestors were believed to be near to God and could communicate with God more easily than before their death. In that sense the ancestors act as mediators between God and living human being and vice-versa. They know the needs of men, they have recently been here with men, and at the same time they have full access to the channels of communicating with God directly or, according to some societies, indirectly through their own fore bearers. They are guardians of family affairs, and may even warn of impending danger or rebuke those who have failed to follow their special instruction...This is to say that in African life the ancestors are very important since the surviving of the living depends much on the dead. The dead leads the living, protect them and are maintaining the social relationship.(Baruti, 2011: 13)

The existence of this forested hill island in a region marked by deforestation and clearance for western-styled cultivation in itself may indeed signal the connections to the past by the people that are associated with the mission. The tie between ancestral knowledge and health has certainly been made before, as Golden and Comaroff observed that traditional food taboos in Madagascar “likely protects local people from zoonotic disease, allergies, and toxins”(Golden and Comaroff, 2015: 42). There does seem to be a connection here in terms of biodiversity/complexity and the presence on the excursion of different Lushoto

district sites of various histories of bubonic plague. The following site had some presence of bubonic plague, but to a significantly less degree that was seen in the first two photographs. Notice the biodiversity/complexity also seems to be greater than the previous bubonic plague site.



Fig.4.9. A Moderately affected plague area of mixed vegetation in Lokome-Shume area. This scene shows greater variety of vegetation than seen in the cash cropping areas using western agriculture, while have much smaller outbreak of the Plague. Photo taken in the Lokome-Shume area of the Lushoto District, Tanzania during an excursion of the LEPUS Conference Soils, Land Use And Plague.

There are certainly many factors that go into vulnerability for an infectious disease epidemic, but a sustainable ecology is one of them. Tanzania being a country of mass migration in the second half of the twentieth century, also highlights the limitations of local knowledge that many people have not lived on the lands of their ancestors. Thus, the people living on foreign lands were in need of assistance, but what kind? It seems a multi-disciplinary team working on the local level was having success:

A further attempt to prevent outbreaks of the disease in the area was the formation of a Permanent Plague Control Team (PPCT) in July 1987 which was charged with, among other things, ensuring that all plague control measures were promptly and properly implemented. These included

early reporting and treating of cases and contacts, flea and rodent control, environmental cleanliness, proper quarantine measures and teaching of appropriate health education. The team consisted of the District Medical Officer, a senior medical assistant, a senior agricultural officer, a health officer, and a community development officer at the district level, and a minimum of 20 health assistants in the infested villages. The activities of the PPCT, in collaboration with village health workers, were probably responsible for the reduced plague mortalities observed during the 1988/89 outbreak. From July 1989 the PPCT became less active and rodent and flea control measures were not carried out regularly due to financial constraints. As a result severe outbreaks occurred in 1989/90 and 1990/91 and involved some new localities, thus expanding the focus to over 45 villages. (Kilonzo, Makundi and Mbise, 1992: 324-325)

Case-study approaches have been well established as best practice in both community and individual levels in medical and social service assessments. Due to the large amount of variables that could be relevant in cases such as this, centralized or single discipline approaches are much less likely to identify these factors and how they interact with other variables (Stokols *et al*, 2003: 521-539). The observation below is an example of the need for thorough and multi-disciplinary research. The narrative associated with bubonic plague, dealing with the black rat and the flea, has not been witnessed in modern outbreaks. The outbreak in the Lushoto District of Tanzania had observed various potential hosts and a lack of rodent fleas during an outbreak:

The observation that the population density of *P. irritans* (a house flea) remained high throughout despite house spraying and/or dusting with 1.0% cyfluthrin, and that outbreaks of the disease occurred from 1988 to 1990 despite the low population densities of rodent fleas during that period, suggests the possibility that *P. irritans* is not susceptible to the insecticide and that this species is involved in murine transmission of plague in the area. (Kilonzo, Makundi and Mbise 1992: 326, 328)

Furthermore, the high incidence rates of the disease in 1989 and 1990 when the rodent populations were generally low, absence of plague signs in rodents during the period and the significant presence of specific plague antibodies in 6.3% of domestic dogs, can be interpreted to suggest that rodents are not the only reservoirs of the disease in the focus and that dogs are possible carriers of plague in the area. However, possible

existence of the pathogen in the soil and/or other domestic and wild animals cannot be ruled out and an investigation to substantiate this possibility is recommended. (Kilonzo, Makundi and Mbise, 1992: 328)

Laudisoit *et al.* found that there was a much greater prevalence of *Y-pestis* in human fleas rather than rodent fleas in one outbreak site in the Lushoto District (Laudisoit *et al.*, 2007: 687-693). Also, dogs, cats, prairie dogs and dozens of other small mammals have been found to carry *Y-pestis* (Mani and Maguire, 2009: 164-174) and recently there has been DNA evidence of bubonic plague infecting people without the flea transmitting the disease (Rasmussen *et al.*, 2015: 571-582). Subsequently, focusing upon contextual vulnerability factors looks to be the more fundamentally secure predictors of outbreak areas for epidemics, rather than focusing upon a particular insect, animal host species, or variant of a bacteria or virus. When focusing on contextual vulnerability factors, the higher risk areas typically do become apparent. Parker *et al.* illustrates some of these areas that include anthropogenic changes (i.e. deforestation), food and nutrition security, parental care and education for children, scarcity of water and needed resources. (Parker *et al.*, 2007: 5)

Changes in land use and land cover can modify the local climate and its patterns. Furthermore, land cover change affects diversity of species including disease vectors. Extensive reclamation of natural swamps in the highlands of eastern Africa has led to local warming in the swamp microhabitat and the proliferation of *Anopheles gambiae*, the world's most efficient malaria-transmitting mosquito. The phenomenon may have led to an increase in malaria in the highlands. Deforestation causes local temperature to rise by about 0.5–2 °C, and this has increased the rate of malaria transmission in the highlands of western Kenya. (Parker *et al.*, 2007: 21)

Though malaria and the bubonic plague are generally thought to be in mutually exclusive climate zones, this has been an increasing overlap area in the highland East Africa. Parker went on to state, "Since 1988, epidemics have become frequent on the eastern African highlands, with up to 300% increase in the number of cases reported in hospitals" (Parker *et al.*, 2007: 5) The greater focus of East Africa's agriculture upon cash-crops has required more lands for cultivation as well as more intensive use of the soils. Vulnerability on market prices, decreased soil fertility and water availability, poor crop yields have

stressed food and nutrition, as well as heightened childhood malnutrition (Parker *et al.*, 2007: 5).

As noted earlier, malnourished children have weakened immune systems that will typically remain so even in adulthood. The increased amount of labour required for cash cropping has also been associated with mothers weaning their offspring early, due to the high demands of work in the fields. This has also been associated with infants poorer immune system functioning. Food and nutritional security goes beyond the amount that is produced in the fields. Social organization and networking may play a part in food and nutrition security, which traditionally were reported to have increased the sustainability of a whole community. (Nyerere, 1985: 236-237)

4.11 Education for the Global Trade-based Economy Set the Stage for Ecological & Biological Change through Human Activity

The socio-economic systems inherited by the post-colonial governments were designed to extract resources for a cheap price for the benefit of the colonial government and those it represented. The systems were not constructed to distribute food and needed resources as efficiently as possible to people within the colonised country. The local people were often locked out of the most profitable part of the colonial economy and that continued in the early post-colonial governments. Mlekwa (1976) explains the effect of this restriction for two Tanzanian peoples:

The Wanyamwezi and Wasumbwa were historically great traders, but their position changed with the development of the colonial economy. ...95% of the districts traders are “foreign” origin.

There were barriers for colonized, some of which was language and education for the new economy. The colonized were selling their resources to overseas markets that they were not familiar with and they were basically shut-out of that end of the market. Colonial education was set up for the creation of local administrative/bureaucratic middlemen to deal with the local producers for the benefit of external investors.

(Colonial education)...was not designed to prepare young people for the service of their own country; instead it was motivated by a desire to inculcate the values of the colonial society and to train individuals for the service of the colonial state. In these countries the state interest in education therefore stemmed from the need for local clerks and junior officials; on top of that, various religious groups were interested in spreading literacy and other education as part of their evangelical work. (Nyerere, 1985: 236-237)

This colonial education has continued in Tanzania and the rest of the post-colonial world was based upon this system of literacy. The reading of documents as the means of keeping authority and a large, centralized system organised and functioning was the new “ecosystem” of esteemed information. No longer was inland Tanzania the land of subsistence economies that required reading the ecosystems (to determine what was in abundance and could sustainably use). Survival in the new trade-based economy was determined by foreign markets with foreign rules that literacy gave access to. Adult education in Tanzania in the 1970s was interpreted to mean literacy. Mlekwa illustrated this through his research of individuals and institutions:

1. The professional adult educators, five of whom were interviewed, understood adult education to include literacy, functional literacy and continuing education.
2. The Party, including affiliated bodies, Government and Parastatal leaders, 29 of whom were interviewed, tended to understand adult education only in terms of functional literacy.
3. The adult learners, including those who had been awarded certificates, ten of them altogether, considered adult education to be merely literacy. (Mlekwa, 1976: 153)

The focus of continuing education on literacy as the essential part is quite illustrated here. It was apparent to the people that literacy was key to take part in the global trading economy, which they now were part of. Unlike traditional economies that depended upon continually *reading* the local ecologies that they depended upon, now they were required to know about foreign markets and global trade, which is governed through the written word.

V. Discussion

Going back to the Laudisoit's, Begon's and McMichael's vulnerability factors of zoonotic infectious disease epidemics (See pages 136-137) we can see a change in vulnerability has indeed occurred.

Begon's fourth vulnerability factor for an infectious disease epidemic, *The increased potential for human to human transmission through greater population densities & increased movement both within and among different populations*, is the easiest of his points to account for. As Kjekshus and others have stated, the 19th century saw a population increase with greater densities as trade, agriculture, and mining all grew to produce substantial wealth surpluses. The re-organisation of East African society started with German occupation, intensified with the British and entrepreneurial agricultural investment strategies that drew some families to move to more fertile areas of cultivation. The Villagization program of post-colonial Tanzania was the most dramatic, resulting in moving 11 of 16 million Tanzanians. Additionally, refugees from the Tanzanian borders came in huge waves, with a peak in the 1980s and 1990s. Therefore, it is clear that this vulnerability factor was clearly present. As greater populations lived in smaller spaces, as was vividly seen in the Villagization program in the 1970s, so their impact on the surrounding ecosystems was more intensive. This led to increased deforestation and clearance as the food subsidies ran out. This fragmented forest areas and simplified ecosystems in agricultural and settlement areas. Thus, Laudisoit's factors of *High population fertility and the population growth next to hotspots is higher than in non forest areas, Encroachment in forests, land use changes and conversion of land in agricultural surface*, as well as increase in edges of the forest as these regions are broken down into smaller fragments, leading to greater human (anthropic) disturbed surface and a greater interface between humans and fauna and the zoonotic pathogens they carry (Laudisoit 2017) are also exemplified here. The continued infringement on the forest environment from the time of German colonisation increasingly fragmented the forests, unsustainably tapped into its resources, and

expanded to new settlement areas. Laudisoit's *trade of forest products and bush meat and the illegal or uncontrolled nature of trade* was also certainly seen as resources were becoming increasingly scarce and insecure as these resources were just a military deployment away from being denied to the local people that depended upon them. Therefore, people gathered resources at an unsustainable pace, as seen in the gathering of firewood from nearby forests. The incentive to hunt livestock predators and animals that would have eaten their crops would have been very high, and the disappearance of the bird and animal life was noted by various Europeans who travelled through East Africa during and after the colonial period. These animals could then be eaten or traded to provide for peoples needed nutrition, while also protecting their livestock and crops. The deforested areas would have altered the hydrosphere as there would have been a lack of trees to take water, while ploughed soils would have increased the rate of evaporation. The cleared and deforested areas would have been a bit warmer than surrounding areas (0.5-2 degrees C has been suggested). This micro-climate and habitat change (McMichael's sixth factor 2004) could attract rodents, especially with grain stores nearby (McMichael's first factor 2004). The re-settlement of people into new lands meant there was a shortage of fertile, agricultural lands. The lands that were cultivated were often planting foreign cash-crops (i.e. tobacco) and over-intensively using the soils, leading to poor yields (and poor food and nutrition security, *increasing vulnerability of human populations to infectious disease*- Begon's third vulnerability factor (2013). Additionally, the introduction of foreign crops (Begon's second vulnerability factor (2013)), which often occurred in newly deforested and cleared areas, would have changed the ecosystem dynamics and potentially gave a great competitive advantage to opportunistic species that have more dietary flexibility and the capacity to quickly reproduce in large numbers.

The size of cattle herds also increased while the ecosystems of territory were in a dramatic state of flux as war, migration, and cultivated areas changed quickly since the late 19th century. The implication is that herders would not have known the environments they were bringing their cattle through as well as in the past. Thus, the tse-tse fly had a better chance to infect the cattle. The larger herds developed for larger-scale trade led to more breeding without expanding

the number of species, leading to a relative lack of species variety. This may have made it easier for diseases including the European introduced viral infectious disease, rinderpest, to spread. As the herds increased in size and as the forested areas were in flux, the possibility of cattle going into forested areas was especially high. This combined with the probability that the wildlife population was in decline might have made the cattle and other livestock, herders, and people in settlements host candidates for insects transmitting parasites. Brearley *et al.* note that “landscape change can alter ecological and evolutionary processes, including those between host and parasite. Critically, human-induced landscape change and activities have been considered to be drivers of emergent infectious disease (EID’s) of wildlife” (Brearley *et al.*, 2013: 429).

When looking at the past the first of Begon’s vulnerability factors, *An increased presence of emerging infectious disease in wildlife*, is typically going to be speculative. However, we can see that there has been changes in areas at risk of the tse-tse fly, areas of malaria-carrying mosquitos, as well as bubonic plague prevalence escalating. This signals a change had occurred in the wildlife, maybe as rodent burrow densities increase in the context of a lack of predators that population became more vulnerable.

Applying McMichael’s, Begon’s, and Laudisoit’s risk factors in this assessment, we can address the first question from Table 1 from the Methodology chapter can be addressed, which states, ‘Based upon the vulnerability factors for a human zoonotic epidemic,²⁸ is there evidence of heightened risk at the site?’ as well as the third question, ‘Is there evidence of deforestation, vegetative clearance, &/or erosion?²⁹’

The level of risk for the Plague in the Lushoto district did seem to vary based upon the McMichael’s, Begon’s, and Laudisoit’s vulnerability factors. The areas that were especially dependent upon cash-crops, which also were the most deforested regions and thus required people to chop firewood in nearby forested areas, were also the regions of the highest incidents of the Plague. Whereas the area least affected was that of the Shambala people, which was also the most

forested settlement area that we visited. Agriculture was interwoven in the forested environment and there was not the dramatic ecological change caused by deforestation that lead to forest fragmentation most typically for agricultural areas seen in the high risk areas.

The second question from Table 1, 'Is there evidence of food insecurity & malnutrition/co-infections?³⁰,' is seen through the history of the region. The migration in the region, particularly with refugee migration in the 1980's and 90's, illustrate the greater risk for food insecurity, malnutrition and the heightened risk of various infections that the people may have had moving to these new lands. These agricultural plots that were settled were often marginal lands that would not be well suited for western-style agriculture. However, these people that migrated to the Lushoto area typically came from different ecological regions, and were not knowledgeable of the ecological systems that they found themselves depending upon for their livelihoods. However, the Shambala, have the longest history of settlement in the region and therefore were familiar with how to sustainably survive off the land.

The fourth and fifth questions focus on the establishment of institutions of education and enculturation that leads to economic and ecological change. These points of inquiry, are as follows: 'Is there evidence of deforestation, vegetative clearance, &/or erosion?³¹,' and 'Is there evidence of trade/economic change leading to educational/enculturation change in society?³².' The degree of intensity of western education and language training in Lushoto, Tanzania is also divided between the more recent cash-cropping settlers and Shambala. Migrant labour under German and especially British colonial and the early years of independence became common for new agricultural settlements or new mines, which separated people from the ecologies that they would have been familiar with. The new education was based on a European tongue that had no tie to the ecologies they would be working in. This frame of thinking brought people from focusing upon their local ecologies as the foundation of their education to texts as the basis of knowledge. Thus, schools and libraries increasingly became the

‘environment’ for knowledge that the new economy and social organization was based upon. The emphasis on English reading and writing during the British colonial period as well as after political independence, as these linguistic skills were important for the economic trading economy that was instilled in the region. The post-colonial period’s concentration on Swahili put more focus on the region, but still cannot be considered a language integrated with the local landscape and ecologies as the local languages had been. Rather, it drew people together from vary different landscapes and ecologies under a common language. Therefore, those that had very proficient level of English and Swahili had a very distinct advantage over their counterparts in the development of this large trade system. However, the Shambala people of the Lushoto district had better maintained their native tongue as it was still tied to the ecological systems that it was tied to, which helped continue to grow the environmental knowledge and practices that have been past down through the generations. This led to a relatively more sustained diverse and forested environment on their lands.

The next questions, ‘Is there evidence of growth in Social organisational size & complexity, which diminished the society’s problem solving efficiency?³³’ and ‘Is there evidence of societal instigation of an ecological crisis through unsustainable socio-economic systems and institutions?³⁴’ concentrate on the development of an increasingly large bureaucracy that subsequently diminished its capacity to address issues that the society needs to address for its own well-being. Van der Leeuw (2009) points to a society’s drivers towards a socio-environmental crisis focus on the connection a society has to the ecosystems that they depend upon and how well they are able to observe, adapt and react to those changes in a sustainable way. Societies that live within their cultural geography need to keep a sustainable way of life as their life and that of future generations depend upon it. Thus, their language, education, social organization, and economy are based in the realities of the ecosystems they depend upon. The threat of war and exploitation by another society often leads to unsustainable systems as there is a need to quickly use resources to defend a society against another in the present or near future. European colonialism developed in this

context and colonies were had around the world. The European powers needed people in their colonial lands to depend upon an economy that was not directly related to the local ecologies. Instead they had to get these people dependent upon the international trading economy. German colonialism practice in Tanzania that included a scorched earth policy, and the threat of slavery, forced migration, and the increasing possibility to be killed by advancing military action or the development of zoonotic disease epidemics the became legitimate fears under German and English occupations. Therefore, ecological sustainability would have become a very secondary concern for both native and colonialists in Tanzania. The purpose of colonization is to gain greater access to raw materials and is intrinsically centralized by the colonial power. Thus, Germany and especially Britain developed large administrative systems to the degree never seen in the region. The purpose of these bureaucratic systems was to export commodities in demand to increase the colonial country's wealth, in part to augment their own military capabilities to deal with their own threats. Therefore, ecological sustainability was not a main priority. Additionally, the capacity for these colonial systems to deal with problems of the local people, as Kjekshus argues, was likely diminished as local chieftains were overthrown and life expectancy seemingly diminished as zoonotic disease epidemics became entrenched.

Chapter 5

An alternative Black Death narrative for Ireland: ecological and socio-economic divides on the medieval European frontier

I. Introduction

This chapter is part of an investigation of vulnerability and resilience of medieval Gaelic and English ('colonial' or Anglo-Norman) Ireland. It has two principal complimentary aims, both originating in different disciplines. One is to use Ireland as a case-study to help to understand the roots of systematic vulnerability and resiliency to famine and epidemics (both of which we are now seeing with increasing frequency). The other is to combine that understanding with the results of more conventional archaeological-historical enquiry in order to make a significant contribution to the study of a transformative period in the history of medieval Ireland. A third, perhaps more incidental, aim of the paper is to demonstrate how students of the middle ages, not least of the fourteenth century when northern Europe was affected by one crisis – war, famine, disease – after another, can benefit from bodies of evidence from disciplines traditionally regarded as mutually exclusive. This paper draws on the analysis of zoonotic (animal-transmitted) infectious diseases.

The first part of the paper begins with the common – and uncontested – observation that the native Irish and the English of the fourteenth century were affected in different ways by the plague. It challenges the view that the Irish were spared the worst of the plague simply by virtue of their rural settlement pattern. Accepting the thesis that socio-economic and environmental factors help explain the pandemic, it presents an account of early medieval Ireland that seeks to contextualise and explain the origins of the socio-economic divisions that manifest themselves in the fourteenth century. The second section: 'Planting the Pathogen's Seeds: Post-1169 Ireland and Its Socio- economic Divisions', serves as the foundation for the differences in human activity, resource extraction, landscape change, population density, as well as centralised, hierarchical socio-organizational systems that had led to greater vulnerability to human zoonotic disease epidemics in the areas dependent upon commodity trading and greater

resilience in areas of people with greater resource flexibility and leadership dependent upon support through adequate resource distribution via clan networks.

II. Preparing the Ground: Pre-1169 Ireland and its Socio-Economic Divisions

Contemporary documentation noted that the native Irish did not suffer from famine, illness or Black Death as severely as did those descended from the English (or Anglo-Norman) invaders of the late twelfth century. For instance, the petition to King Edward III of England from the Dublin Parliament in 1360 stated ‘...the Pestilence which was so great and so hideous among the English lieges, and not among the Irish...that the land and the lieges are so enfeebled by the said enemies that they can nowhere be defended nor protected, as formerly, save by the presence of your said justiciar’ (Richardson 1947: 21). Archbishop FitzRalph of Armagh had a similar call for help when he preached before the Pope at Avignon in August 1349, stating that the plague killed more than two-thirds of the English, but did not affect the Irish or Scottish (Ellis 2006: 182). Giraldus Cambrensis (Gerald of Wales), who observed (or at least perceived) the ecological and health differences in Ireland about 150 years before the Black Death stated of the west of Ireland that ‘anyone born here, who has never left its healthy soil and air, if he be of the native people, never suffers from any of the three kinds of fevers... (O’Meara 1982: 34-35).

These perceived differences between the native Irish and the colonists in Ireland may be seen as an example of a phenomenon that was taking place on a larger scale and that was associated with distinct diets and eco-economic systems. Still, why it does appear that many native Irish survived much better than their colonial counterparts during the famines and Black Death of the fourteenth century? There does not seem to be evidence of a systematic distortion or change in the colonial record keeping or that such events went unrecorded in native sources. To underscore the latter observation, it is instructive to note assiduously how Irish annalists – chroniclers – recorded both extreme weather events between AD431 to AD1640 (**Fig. 2**).

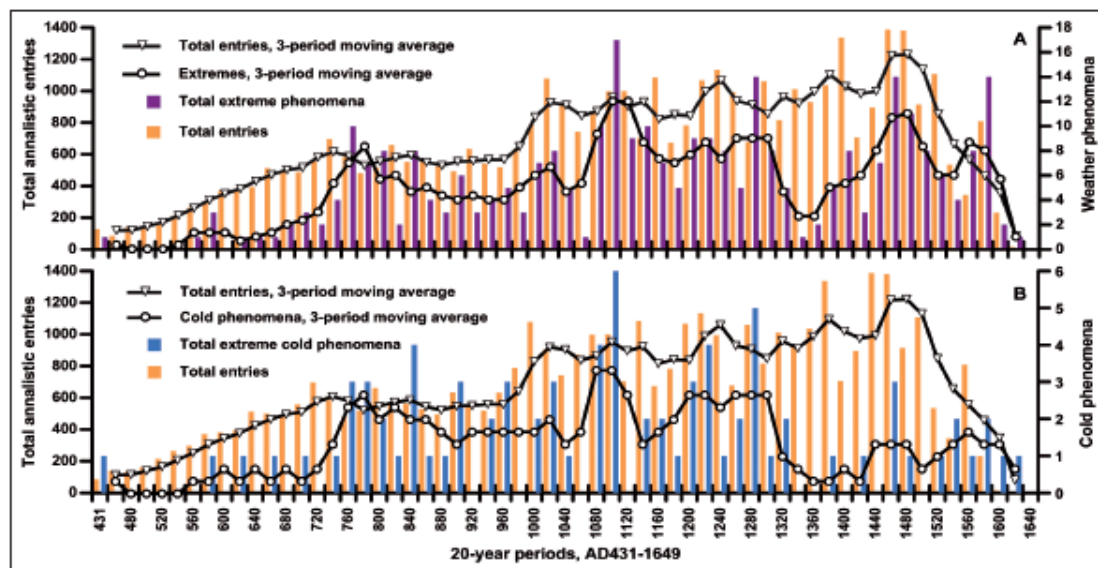


Fig.5.1. Frank Ludlow's analysis of sixteen Irish annals with the top chart showing total reported weather and related phenomena and conditions, and the lower showing the number of reported extreme cold phenomena (Ludlow 2012:118-119). It is noteworthy here that the most consistently elevated period of extreme phenomena is from the twelfth to the early fourteenth century, a period of economic wealth and agricultural expansion. It is also important to note that agricultural areas have less 'insulation' in that there is less density of plants and trees, thus the ground temperature and moisture levels would have been more volatile (Findell *et al.* 2009:3249-67; Legates *et al.* 2011:65-66; Li *et al.* 2015:6; Luyssaert *et al.* 2014: 389-393; Mahmood *et al.* 2014: 929-953) which could be devastating for crops in an arable economy. The effects of regional landscape-cover change are well documented for their impact on climate.

To access whether socio-economic systems and infectious disease-ecology research are related in the Irish context, we first need to probe deeper the evidence for a socio-economic divide in medieval Ireland. That involves bringing us back in time to the early Middle Ages, the tail-end of which was observed and commented upon by Giraldus.

A starting point is a review of the impact in Ireland of legal systems upon the colonists and native Irish. Van Krieken has highlighted basic differences between English and Gaelic law on the issues of private property and criminal law. (2011:

38-39) The former focused on individual rights, responsibilities, and ownership with private property and criminal law, whereas the latter centred upon group ownership and fair compensation guidelines through a civil law code. The former focused on severe punishment to sustain the status quo and create an environment advantageous for trade, while the latter focused on compensation for damage done to a clan.

Medieval Gaelic (or 'Brehon Law') does seem to have focused on maintaining a traditional way of life, but it was also skewed toward the economic interests of a landowning elite. The most relevant Irish law-text for this topic is *Bretha Comaithchesa* (literally, 'judgements of neighbourhood'), which 'deals with the division of land among heirs, fencing, trespass by livestock and pets, damage to trees and bushes, and other problems which may arise between neighbouring farmers' (Kelly 1998: 503). According to Katherine Simms, Old Irish Law tracts were 'originally written in an ecclesiastical context between the late seventh and the ninth centuries, they have been transmitted to us in vellum manuscripts of the twelfth to the sixteenth centuries' (Simms 2009: 91). Law manuscripts were preserved through ecclesiastical and elite patronage of learning. They may be seen to reflect the interests of wealthy donors and churches, who owned prime agricultural land. It seems reasonable to say that large farmers had a disproportionate influence on Irish law. *Bretha Comaithchesa* supports this argument through its focus on private property rights, often specifically for the benefit of agricultural land owners.

As Gaur has noted, socio-economic systems of small-scale herders, agriculturalists, and hunters have been able to do without a phonetic-based script and rely solely on the flexibility and adaptability of oral tradition to adjust to changes outside of their control. However, large-scale trading socio-economic systems need to depend on written script, typically a phonetic-based script, as the rigidity of the written word is necessary to fulfill the requirements of trade and administration (Gaur 1992: 15-16). Written laws create a new man-made environment of knowledge which facilitate property accumulation and expansion. One might argue that the natural authority, thought to have given the Irish kings the right to rule in the Gaelic-Irish tradition, was under threat by the

economic expansionism of the trade-based economies that were in desperate need of more raw materials to expand the early medieval European trading economy. If we go back to the end of prehistory and to the earliest medieval period in Ireland, one can observe strong indications that the island was being drawn into an economic relationship with the economically complex text-based Empire. This economic trade link pre-dates the religious influences brought to Ireland through Christianity (Freeman 2000: 1-26, Kelly 1998: 4). Christianity may have been adopted, among other reasons, due to the perceived economic benefits that could be had through adopting its religious teaching and influence. Evidence of this Irish economic relationship with the former Empire is seen in the Latin vocabulary and phonetics loaned into the Irish language from around the first century A.D. (McManus 1983; Ó Riain 1989; Freeman 2000: 14-17). For instance, the early Irish vocabulary often has an association with trade, as witness the early Irish words *dírna/dinnra* (*denarius* in Latin) meaning 'weight', *ór* (*aurum* in Latin) meaning 'gold', and *sesra* (*sextārius* in Latin) meaning 'a measure of capacity' (McManus 1983: 43). Such linguistic markers indicate that new skills or activities were learned through trade with the late Roman Empire and incorporated into certain segments of Irish society. As might be expected, Roman influence was not evenly spread through Ireland and sections of Gaelic-Irish society remained relatively independent of continental influences. The Irish Laws supported the growth of crop-farming to the detriment of those who lacked private property, particularly landholdings. It would be a mistake to believe that these laws were strictly followed, but they do show the power of landholding elites in early medieval Ireland.

The streamlining of agricultural production to generate profit was not a significant part of the early medieval Irish economy. Medieval Gaelic Irish poetry is full of reverence towards nature, and kings were seen as mediators between the natural world and society (Low 1996: 92). Those aspiring to greater influence and power in early medieval Ireland were, arguably, tempted to adopt the European agricultural economic system to generate surplus wealth. We can probably map this from at least the eighth century to the eve of the English invasion. An increase in trade from ecclesiastical centres from the eighth century

can be charted in the pollen and archaeological record. As McCormick notes, 'cereal production appears to grow in importance as subsistence farming gave way to the production of agricultural surplus. This is reflected in cereal diversification and in the construction of watermills and more efficient grain-drying kilns. At the same time, settlement underwent significant changes and the relative importance of cattle in some areas began to decline' (McCormick 2014: 119). The Viking Age, starting AD800, saw a continuation of this re-alignment, through the agency of trade, in the balance of wealth, power and influence in Ireland. A large number of Viking coin hoards found at ecclesiastical settlements show their propensity for trade in comparison to the distribution of less 'economically active' coinless and mixed bullion hoards that were more widespread in Ireland (Sheehan 2008:49-63). In the tenth and eleventh centuries, the period when feudalism developed as a form of social-economic-political organisation in post-Carolingian Europe, there was, arguably, a trend towards development of new secular (as distinct from 'monastic') nucleated settlements in Ireland, indicated by the term *baile* (O'Keeffe 2001: 22-27). Such settlements, being places of stability, would certainly have allowed the continued expansion of cereal production, and many would have been, almost by definition, central places in trading networks. It cannot be a co-incidence that the English invasion of the late twelfth century was most successful in places – in the eastern half of the island – where arable cultivation was dominant, and where the early capture of nucleated settlements allowed control be exerted briskly. The Gaelic areas beyond the English frontier were different. There, pastoral farming was probably stronger. Kieran O'Connor has suggested of the post-1200 period that 'the settlement pattern throughout Gaelic-dominated parts of medieval Ireland seems to have been predominantly dispersed, with most population living in scattered farmsteads or small house clusters' and that 'the economy was largely pastoral, with transhumance or booleying being practiced as part of the yearly agricultural strategy...' (O'Connor 1998: 109).

III. Planting the Pathogen's Seeds: Post-1169 Ireland and its Socio-Economic Divisions

The English colonisation of Ireland in the late twelfth century should be understood within the wider contemporary context of European expansionism or, as Robert Bartlett has coined this process, 'Europeanisation' (Bartlett 1993). As Bartlett has noted, there was no concept of Europe as a united geography until western Christendom was defined by the church (Bartlett 1993). The first European economic union was formed by the Church in its campaign to unite secular support. The uniting force was not the kings, but the ecclesiastical hierarchy, with its central control in Rome under the Pope as the highest authority. The impact of this union can most easily be seen during the series of wars called the Crusades. Pluskowski, Boas and Gerrard have illustrated the tie between European colonisation, the Crusades and changing ecologies. Their observations are of interest in the present context. They explain:

...while the character, chronology and cultural impact of the crusading movement in different regions could vary quite dramatically, in all cases it was accompanied by a process of colonisation. This impulse was not peculiar to the frontiers of Christendom; in fact, colonisation characterised a fundamental aspect of European societies from the 11th to 13th centuries AD. The expansion and movement of European populations was closely tied to the increasing exploitation of natural resources. This was more than just an economic or demographic expansion, however; the centuries of the medieval warm period saw a new definition of the human ecological niche. People aspired to manipulate their local environments to suit their changing socio-economic and ideological requirements, a tendency that was most pronounced in colonised regions. An ecological perspective in this context focuses on environmental transformation arising from changing patterns of human activity, resulting in the creation of new ecological niches (Pluskowski, Boas and Gerrard 2011: 192-193).

The ecological impact of the crusaders depended on the ecology and ecological change fostered by the population that preceded them, the stability of the area they colonised, and the landscape and geological characteristics and climate of the region. The vulnerability factors for an infectious disease epidemic would have increased due to the impact of the activities of these Christian invaders. Brearley *et al.* have illustrated the heightened vulnerability a population has as it

dramatically alters the landscape, creating changes in the ecological habitats and biodiversity:

Human-induced landscape change is increasingly recognized as impacting the health and fitness of animals in habitat fragments. Habitat loss and fragmentation reduce the amount and connectivity of suitable habitats. This affects population viability, lowers genetic diversity and causes inbreeding depression, potentially making individuals more susceptible to existing or novel diseases and stochastic environmental events. The contribution of infectious disease to the decline of susceptible wildlife populations may increase the quantity and quality of suitable habitat declines (Brearley *et al* 2013: 427).

The Baltic states often had even more dramatic change during the Crusades, as Stivrins *et al* explain. ‘The Crusades replaced tribal societies in the eastern Baltic with a religious state (Ordenstaat) run by the military orders and their allies, accompanied by significant social, cultural and economic developments. These changes have previously received little consideration in palaeo-environmental studies of past land use in the eastern Baltic region, but are fundamental to understanding the development and expansion of a European Christian identity.’ They go on to note, ‘the local landscape was still densely wooded until the start of the crusades in AD 1198 when a diversified pattern of pasture, meadow and arable land use was established’ (Stivrins *et al.* 2015:1). During the Crusades the Baltic States witnessed a split between the rural areas that maintained a strong tie to the landscape, which remained pagan (Pluskowski *et al* 2011:209), and urbanising areas, which had a greater tie to militarism and international trade, which became more Christian. Bartlett observes this period as being one of a great intellectual conversion, “the enormous transformation in the educational curriculum that took place in western Europe between 1150 and 1250” (Bartlett 2008:32) and cites Max Weber in explaining that the change was “marked by the growing dominance of rationalism and an increasingly instrumental attitude to the natural world” (Bartlett 2008:33). Kaye (as seen earlier in the first chapter) explained the reason for such a transformation being the dependency on a cash economy, where people’s livelihood depended upon cash to pay for their necessities and taxes. Therefore, numeric information, as weight based in a numeric system and market prices, along with the contractual terms of the trade,

became critical information, and as such the assessment of the natural world was in accordance to numeric and literary tools. This transformation allowed for quick assessment of wealth or of the potential quantity of wealth to be earned, which helped foster the quick and large-scale exploitation of resources. This cognitive system change in assessing nature was needed to support large military campaigns, as the Crusades.

The Baltic frontier of Christian Europe is an example of comparison for analysing Ireland. Here the contrast between rural traditionalism verses urbanisation with increased trade, military power and the reforming ideology of the Roman church contrasts the rural ties to the natural environment and traditional ways of life. This distinction in ecologies will become more obvious in thirteenth- and fourteenth-century Gaelic Ireland (which will be discussed below), but the Church's economic system based on long-distance trade for wealth production leaves clear ecological evidence when it took hold of new territories.

The Church sponsored the Crusades and the economic change that took place on the new Crusader lands. This bears some comparisons with the English colonisation of Ireland. The economic system that both the Church and Europe depended upon was long-distant trade and economic expansionism that entailed less focus on the ecosystems that surrounded them and more upon market demands in faraway places. Increased exploitation of natural resources was needed to accumulate wealth, build a strong military and a defensive system to protect territorial assets. Subsequently, new lands and resources were required to maintain and expand power further. Ireland was a frontier land for both England and the European economy. It is in this context that the socio-economic systems of the later medieval Gaelic-Irish may best be understood.

O'Connor has written that 'the relationship between the Gaelic lords in ...(Gaelic) regions and the Anglo-Normans and colonial government varied considerably from virtual independence in some areas to the status of rent-paying tenants in others' (O'Connor 1998: 73). This divide between independence and rent-paying tenants is an important one to note. Rent-paying tenants needed to be part of the system of wealth-production and they would need to create a surplus in order to

have enough for themselves to live on. However, this was not a prerequisite in more independent Gaelic areas and there is archaeological, palaeo-ecological and historic evidence to suggest significant differences existed.

To understand Gaelic economic divisions from the English colonisation of Ireland, several factors need to be taken into account. These include the differences between English and Gaelic law, settlement forms, and the pollen evidence of regional ecologies. We can discuss these briefly, in order.

5.1 Law

Gaelic law was civil law. Landed property was for the most part co-owned by the clan, and when damages were done by one individual to another, repayments went from one clan to another. No matter what the offense was, from murder to small-scale theft, the victim's clan could claim compensation through the laws if it was powerful enough to do so. Laws ultimately support the well-being of an economic system that people depended upon. Thus, this system of clan-based compensation gave incentive for clans to become strong. It seems unlikely that a weak clan would gain compensation from a strong clan. Thus, clans had reason to be on guard against raiders and to raid others when the opportunity presented itself. Calloway explains how this socio-economic system runs, whether it is in the Scottish Highlands or in the Great Plains in the United States: "Lifting' cattle in the Highlands was as common as horse raiding on the Great Plains and served some similar purposes. In a region of scarce resources, rustling cattle, stealing grain, and burning fields enhanced a clan chief's ability to support and feast his followers and reduced a rival's capacity to do the same (Calloway 2008: 24).

Gaelic military service was organised to support the socio-economic system of mobile pastoral herding. This is different from English and continental militaries that served to protect permanent arable production and expand the settlement area of agricultural production. The Gaelic military was put a premium on adaptability and flexibility. Frame illustrates this military focus within Gaelic society:

The pastoral emphasis of Irish rural society ensured that cattle-raiding was a chief feature of the military life. It was a way of pursuing local disputes; on a grander scale, it was a means by which Gaelic Irish and Anglo-Irish magnates asserted their power by exacting submission and hostages and imposing services. The 'official wars...were mostly of a similar type: the normal aim of the king's ministers who conducted them was not so much to occupy or (as was more to the point in the later Middle Ages) reoccupy land, as to exercise lordship (Frame 1989: 101).

5.2 Settlement

The adaptability of Gaelic society in the later Middle Ages is represented in settlement forms. There is very limited archaeological evidence of medieval Gaelic housing, but O'Connor has highlighted two types of simple peasant houses existed in Ulster until the end of the Middle Ages, the 'creat' ('a small, one roomed, windowless house of circular or oval plan...very simply constructed of post-and wattle, covered with sods') and a more substantial sub-rectangular house constructed of clay or sods or post-and wattle covered with clay with a thatched roof supported by cruck-trusses (O'Connor 1998: 95). The relative lack of archaeological evidence of Gaelic homes in Ireland is itself a sign of the lack of investment they had in their homes or else there would be a greater presence of them in the landscape. Therefore, these simple homes can be seen as part of the divide, making them distinct from the English colonists.

While the Irish did not live in strong, well-built homes, there were some that made significant fortifications to protect against raids from other clans. In the early Middle Ages this included crannogs, moated sites, cashels, and larger ringforts (O'Connor 1998: 96-97). In the later middle ages these comprised motte and bailey or ringwork castles and later tower houses. Loeber notes that before the last quarter of the fourteenth century, 'several Irish chieftains had exchanged their native residence for a stone castle originally built by an Anglo-Norman lord' (Loeber 2004: 291).

5.3. Vegetation

According to my study of pollen evidence from medieval Ireland, the greatest concentration of traditional Gaelic vegetation types are dramatically concentrated in the north-east of Ireland by the early-mid fourteenth century. However, the north-east was very distinct from the Irish midlands, which had very notable indicators of clearance and deforestation as well as agriculture cultivation. These very significant regional differences were in contrast to what was happening two and a half centuries earlier. The protected Gaelic vegetation types (consisting of trees and large shrubs noted by Kelly (1999:39-57) of the late tenth century were generally expanding all over Ireland, with the west and the midlands having the greatest growth. The significant population growth of protected vegetation types are shown below in a pollen map of A.D.1100 Ireland within the context of the later mottes and towerhouses (**Fig. 3**).

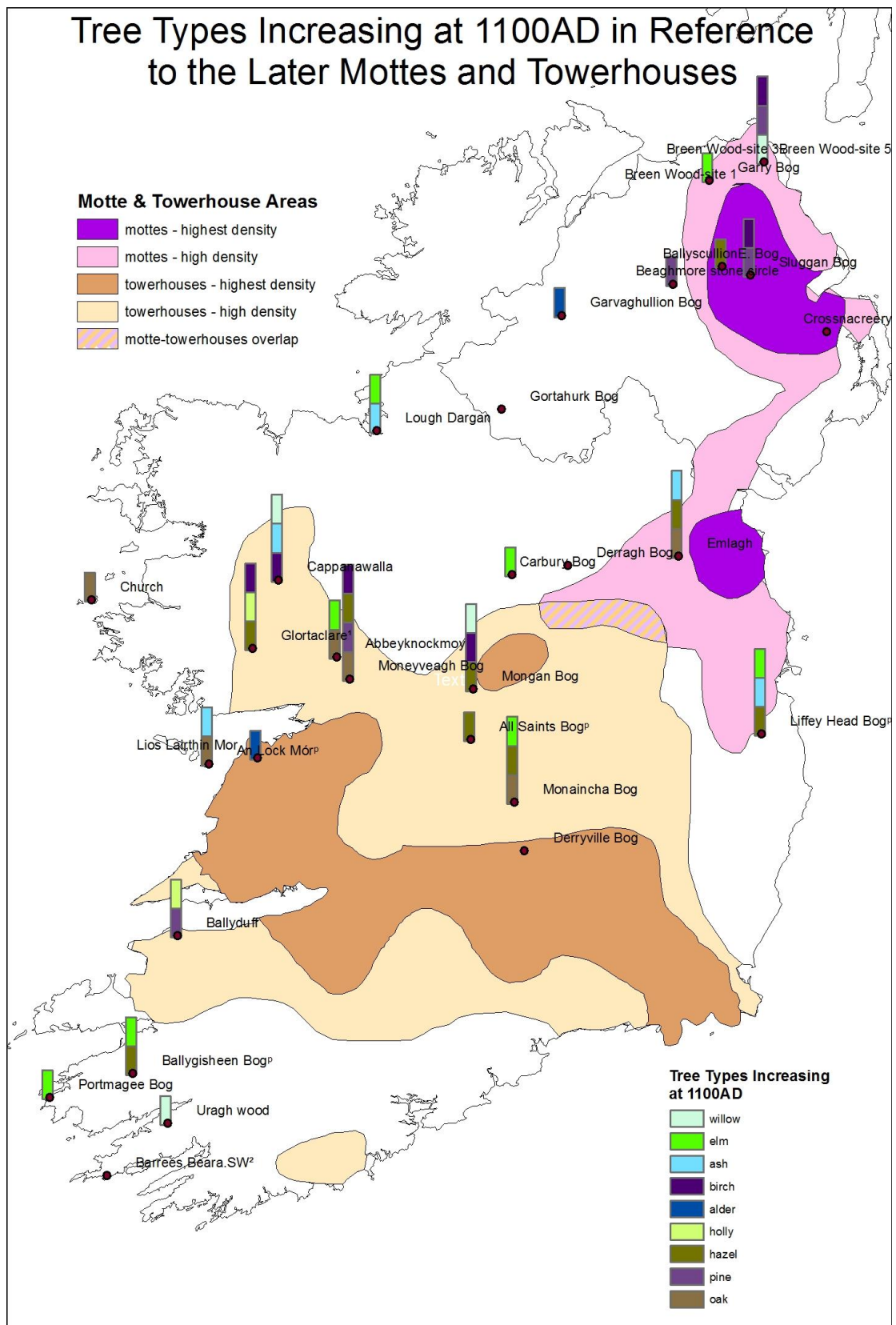


Fig. 5.2. This map illustrates traditionally protected Gaelic vegetation (tree) types were increasing all over Ireland at the turn of twelfth century. This tree-regeneration across Ireland is in contrast to the early fourteenth

century, where the differences in the townhouse and motte regions are very distinct.

The area of high/higher density of towerhouses has been associated with clearance of landscape in the late thirteenth/early fourteenth century, but around AD1100 there does not seem to be much difference between the motte and townhouse regions. The distinction between the 'towerhouse region' and the 'motte region,' of the north-east became very pronounced in the early fourteenth century. During this period, north-east Ireland was the only region where Gaelic forest (of protected vegetation types) was clearly expanding in area and the Midlands stood out as the most agricultural region (though there is a lack of pollen sites in east Ireland). Around AD1100 the greatest areas of crop-farming noted in the pollen studies (though eastern Ireland is under-represented in pollen studies) were the Midlands and the west of Ireland. However, this was very distinctive from c.1350 in that these areas also had significant growth of crop-farming and Gaelic vegetation types. This simultaneous growth of cultivation and the Gaelic forest may be an indicator of smaller cultivation areas and/or geographic change in areas cultivated, whereas in the early fourteenth century larger and/or more permanently cultivated lands may have been more widespread.

The decline of the English colony in Ireland and the expansion of Gaelic territory began in the mid-thirteenth century and continued until the fifteenth century. This late thirteenth/early fourteenth century was a time of vulnerability to war, famine, cattle epidemic, various infectious diseases, and then the Black Death. The perception may have been the Gaels were faring much better during this period of crisis, and that may have assisted the expansion of Gaelic culture. The north-east may have been the ideal terrain and location for resistance to English colonisation and a Gaelic revival through guerrilla military raids on agricultural settlements in the East and the Midlands. These areas witnessed forest regrowth, which served as protection from English military advancement, and provided food and shelter.

The late thirteenth to the mid-fourteenth English movement away from the fringe areas for agriculture might have been tied to the growth of resistance from the Gaels in these areas. Thus, there may have been a migration to more defensible areas of agricultural production. However, some areas may have been over-intensely cultivated later in the thirteenth and early fourteenth century, as Monaincha Bog, which shows a great increase of *cyperaceae* and *sphagnum* with a large decrease of pollen concentration (Duffy 2002: 46-47). If human activity has been a trigger for increased wetness is debatable, as increased precipitation could have certainly cause this. However, it is only in the highly cultivated region of the central midlands on grey brown podzolic soils that there is a great increase in *cyperaceae* and *sphagnum* in the late thirteenth to the mid-fourteenth century. It is also important to note that grey-brown podzols are woodland soils that need fertilizer to sustain cultivation. The major source of fertilizer would have been cattle, however, there was a major cattle epidemic that killed off many if not most of the cattle in Europe (Newfield 2009: 155; Slavin 2013). This may have led to greater desperation in cultivation of land that was losing its fertility.

During the late thirteenth and early to mid- fourteenth centuries we can see an increase of traditional Gaelic vegetation types (species of trees or large shrubs which are common in a forest environment), and the decrease in crop cultivation in northeast Ireland. This seems to be a response to political instability in the region. As Frame explains, 'The main political regions of Anglo-Ireland before and after... the Scottish invasion, famine and plague...lay...in the less stable and definable supremacies of the lords, (with) Ulster...the most extreme example of this fragmentation' (Frame 1977: 8). This instability would help the regrowth of the forest, leading to an ideal environment for Irish raiding.

When analysing the situation in northeast Ireland, it becomes apparent that the boundary of the Irish Sea is actually a door to the Gaelic Isles and Highland Scotland. Duffy notes this Gaelic connection 'is an involvement that is constant and, at times, particularly between Ulster and the highlands and islands of Scotland, all-pervading' (Duffy 2002: 46-47). This Gaelic connection did not just work on the side of Scottish Highlanders and the Gaelic Islanders fighting in

Ireland, the Irish also have a history of fighting in Britain (Duffy 2002: 50). However, the Irish form of fighting differed from the Scottish Highlanders, who had more experience fighting English forces in the long wars of independence. The Irish were raiders, but not so accustomed to a long-term, large-scale war (Frame 1977: 8). Thus, it is not surprising that these Scottish soldiers were sought after by the Gaelic Irish kings, who became increasingly interested in conquering land and gaining the expertise to train their own native Irish soldiers, the *kerne*, to fight for them (Duffy 2002: 99). These Scottish mercenary soldiers settled and became integrated within Irish society (Lyndon 2002: 99).

It is interesting to note that Robert Bruce 'guaranteed the people of Ulster a truce from Scottish attack for one year from 1 August 1317' and he noted that, "all those Irish of Ulster' who were the king of Scotland's adherents and who were to be free from attack by locals' (Duffy 2002: 94). Duffy also suggests that Bruce visited Ulster to gain Irish support for his plan to invade England. The strength of Gaelic culture in Ulster in the later middle ages would be supplemented by links with western Scotland. The map in **Fig. 4** shows the routes of the Bruce invasion from the Scottish highlands and the Gaelic Isles to the northeast of Ireland down to the Irish midlands, which is also the region of forest re-generation.

The Bruce Invasion of Ireland 1315-1318

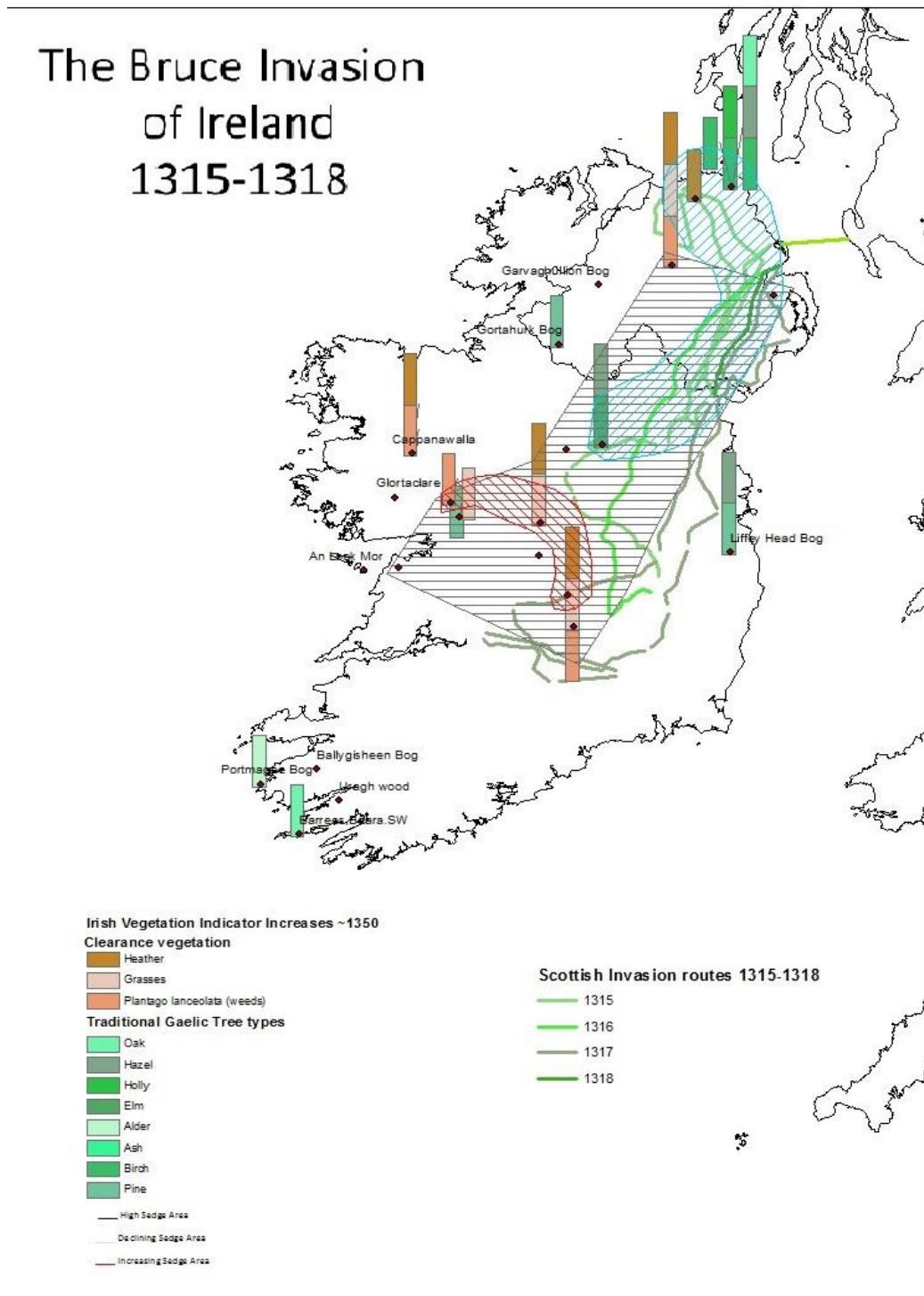


Fig. 5.3. This illustrates the routes of the Bruce invasion that originated from Scottish Highlands and Gaelic Isles, and the re-forestation of traditionally protected Gaelic vegetation types in Northeast Ireland in the first half of the fourteenth century, whereas the Irish Midlands and the West show an increase of clearance vegetation.

IV. Discussion

When speaking of the socio-economic systems and institutions of medieval Irish Gaels it should be done on a continuum with the characteristics of the permanent agricultural settlements of colonial Ireland on one side and the more mobile herders and raiders on the other. It is very probable that most of the Gaels were at least partially integrated into the colonial system of settlement agriculture. This cash-cropping enterprise, which was developed to gain more revenue and commodities for the English crown and nobility, as well as the Roman Church and the orders that established manors on the island. This system led to heavy tax burdens that had the most profound affect on the peasantry, which had to harvest commodities in demand to satisfy paying the taxes as well as meeting their own needs. If the marketplace prices went down for that which they were harvesting or crop yields were down, then more land would have to be cultivated. This began to be a serious issue in the later part of the thirteenth century, as land to expand agriculture became increasingly marginal and the lands that have been continually cultivated were losing their fertility. This led to greater vulnerability for famine and zoonotic disease, as illustrated by the Table 1 inquiries (from the Methodology chapter) below. The first three inquiries, based upon ecological and biological factors will be addressed initially. These inquiries are,

- 1) Based upon the vulnerability factors for a human zoonotic epidemic,³⁵ is there evidence of heightened risk at the site?
- 2) Is there evidence of food insecurity & malnutrition/co-infections?³⁶
- 3) Is there evidence of deforestation, vegetative clearance, &/or erosion?³⁷

The colonial vulnerability characteristics includes all of McMichael's risk factors: *Altered habitat, with proliferation of reservoir or vector populations, Biodiversity change and habitat fragmentation, Ecosystem changes, loss of predators and host species imbalance, Intensified farming and animal husbandry, Niche invasion, and Human-induced climate change* (McMichael 2004: 1054-57). The reason that large-scale, cash-crop agriculture and animal husbandry is especially vulnerable for a human zoonoses epidemic, based upon McMichael's risk factors and is also

exemplified in Laudisoit's *Land-use changes and conversion of land in agricultural surface*, is due to the great transformation that takes place, which very substantially diminishes the innate natural ecological defenses to limit the impacts of pathogens. For a new agricultural area to be realised, deforestation and clearance takes place in order to make room for the fields. The multitude of species that are eliminated or severely diminished not only includes the plant and animal life, but a variety of micro-organisms. Since mono-cultural agriculture or large-scale animal husbandry of a particular species of animal diminishes the diversity and competition for plant, animal, and micro-organism life, it is therefore easier for a bacteria as *Y.pestis* to infect a host and establish itself in an animal reservoir. The reduction of forest area and the creation of cash-crop agricultural environments with the storage of grains that construct the opportunity for generalist commensal species to thrive, brings people in more contact with wildlife, which illustrates Laudisoit's *Encroachment in pristine forests*, and *Increase in edges of the forest as these regions are broken down into smaller fragments, leading to greater human (anthropic) disturbed surface and a greater interface between humans and fauna and the zoonotic pathogens they carry*, as well as Begon's risk factor, *The increased interaction of area wildlife with humans*. Vulnerability of zoonoses in medieval Ireland was also exacerbated by the unsustainability of the demands the colonial agricultural practices were having on the fertility of the soil, which forced even less sustainable practices on marginal lands that would eventually lead to poor harvest yields or famine and may have contributed cattle epidemics from the late thirteenth century. This would in turn lead to malnutrition among the peasantry, leading to weaker immune systems making people more vulnerable to contract disease, which exemplifies Begon's risk factor, *The increase vulnerability of human populations to infectious disease* and may have led to more peasantry to hunt rodents for food, which Laudisoit noted the risk of eating the meat of infected animals, *Bushmeat consumption*. Additionally, cash-crop agriculture is very labour intensive that requires a lot of manpower. Therefore, increased birth rates and population increases are associated with this practice that would have greater population densities in the manors, where people would also have close contact with domestic animals as well as commensal animals, as rodent populations.

This situation would also be noted risk factors for Begon, *The increase potential for human to human transmission through greater population densities and increased movement both within and among different populations*, and similarly for Laudisoit, *High population fertility and the population growth next to hotspots is higher than in non-forest areas*, as well as Laudisoit's *Disturbance of interactions between species causing species range shifts and increased contacts with domestic animals and humans (one health)*, respectively. Begon's first risk factor, *The increased presence of emerging infectious disease (EID) in area wildlife*, cannot be confirmed as being present, though the circumstances of deforestation/forest fragmentation for agricultural cultivation would have greatly diminished the niche many wild animals were living in. Generalist, commensal animals, as many rodent species, would have had the opportunity to thrive with the clearance for cash-crop agriculture, where the competition for food from other wild animals would have diminished. Accordingly, burrows could have become overpopulated, a telling risk factor for developing an animal reservoir for *Y.pestis* and the Plague.

The risk factors for the other side of the Gaelic spectrum associated with semi-nomadic herding and raiding illustrate the substantial differences with the colonial settlement areas. The more mobile herders would have had substantially less intensive impact on ecosystems than their peasantry counterparts, as the herds would move on to the next grazing area and thus overgrazing would likely not be much of an issue. Thus, none of McMichael's factors likely apply to this socio-economic population. However, there are some of Begon's and Laudisoit's factors that could be applied as Laudisoit's *Encroachment on pristine forests*, *Bushmeat consumption*, *Trade of forest products and bushmeat and the illegal or uncontrolled nature of the trade*, as well as Begon's, *The increased interaction of area wildlife with humans*. However, much like the earlier example with the Mongol's, the greater mobility would have made it difficult for *Y.pestis* to have an "animal reservoir" population with humans, as the population is not static enough nor has the density for such a reservoir to take hold. Additionally, unlike the Mongol Empire and the Golden Horde, the livestock population of the Gaelic herders would have also been much smaller as well as more mobile, making them less the ideal for an animal

reservoir to take place. Additionally, the Gaelic herders would have been less dependent upon any particular food source, making them more adaptable.

Regarding the Table 1 inquiries on socio-economic systems and institutions that foster the activities that increase vulnerability or resilience for a human zoonosis epidemic, as the Plague, consists of the following:

- 4) Has there been an increasing emphasis on language built for trade over ecological observation?³⁸
- 5) Is there evidence of trade/economic change leading to educational/enculturation change in society?³⁹
- 6) Is there evidence of growth in Social organisational size & complexity, which diminished the society's problem solving efficiency?⁴⁰
- 7) Is there evidence of societal instigation of an ecological crisis through unsustainable socio-economic systems and institutions?⁴¹

When considering the Gaelic socio-economic divide that affected health, Giraldus Cambrensis' quote on the ecological and health differences in Ireland about 150 years before Black Death is an interesting point to start. He noted, writing for the English crown, "anyone born here, who has never left its healthy soil and air" was said to "never suffer(s) from the three kinds of fevers," which he stated laid in contrast to the British colonists. This period is during what Robert Bartlett has referred to as "the enormous transformation in the educational curriculum that took place in western Europe between 1150 and 1250" (Bartlett 2008:32) where the development of numerological and literary tools were used to take an "increasingly instrumental attitude to the natural world" (Bartlett 2008:33). According to Kaye (See Ch.1), these changes were the result of the transition to a cash-economy, where people depended upon cash for their needs, thereby emphasizing important commodity characteristics for the marketplace, as numeral weight measurements for agricultural goods as the basis for coin values. However, these types of socio-economic changes did not originate in the Middle Ages, but were rooted in the economic growth Roman Empire and were again coming back to life. Such past influences can be seen in the infiltration of Latin in the Gaelic language with the establishing of trade with the Roman Empire that

is evident with trade-based vocabulary. After the fall of the Empire, the Gaelic Church had the height of its influence in Europe and Latin was of great importance in ecclesiastic settings. In order to fund this campaign trade, cash-crop agriculture and larger scale animal husbandry must have had significant importance, as illustrated in the clustering of settlement areas from 800-1000A.D. However, much of Gaelic Ireland was not directly affected by Roman trade, and the island was never under Roman control and thus never experienced being part of a large, centralised bureaucracy until the twelfth century. This cluster movement would reverse and a dispersal period would ensue during the eleventh and twelfth centuries. The tail-end of the twelfth century was the time Giraldus Cambrensis would have witnessed. This was a period with the establishment of more clan-based smaller churches, whose parish districts went in line with clan territories, and mobile herders with booleying up to higher altitude grazing areas as part of their annual movements. This was the setting that British colonial presence began within and the Gaelic socio-economic divide took hold.

On one side of the Gaelic spectrum was with cash-cropping within the colonial system based in long-distance trade that some local Gaelic kings tried to incorporate on their own lands, while the other were the distinct clan-kingdoms, particularly in Ulster, that typically focused on the local cultural geography. This reverence to local ecologies is illustrated in medieval Gaelic Irish poetry, which is full of reverence to nature, as seen in kings being given the right to rule by nature⁴², as their people innately knew they would not be able to survive without nature's generosity. Many of the Gaelic stories note nothing more glamorous in gaining food than hunting for it⁴³, but at the same time there was a great admiration for the animals they hunted. There had been a great emphasis on the observation of the natural environment they lived in, were apart of and depended upon, which would be expressed in glowing beauty. Thus, here in lie the two pillars that led to a great spectrum of the Gaelic Irish during the time of secular and ecclesiastic colonialism in the second half of the twelfth century.

The Church and colonial Ireland were structured for international trade, especially Irish commodities (e.g. cereals, timber, and animal products) to England. The earliest example of continental-style farming in Ireland was the Cistercian Abbey of Mellifont in 1157 (Kelly 1998:20), which predated the British invasion of Ireland. The sacredness of the Holy Scriptures as the knowledge held in the highest esteem, and the Church as the institution to educate people about this, specifically the Pope's infallibility in interpreting such knowledge, led to the Church leading a knowledge economy based in its sanctioned written script. The greater influence of the Church was also seen in the landscape as deforestation and clearance made way for the increased dependency on cash cropping, which heightened the peasantry's dependency on coin. Thus, land for herding made way for agricultural cultivation and more settlement areas with a church and more focus for people to learn the art of letters and numerology. There are also profound differences in the colonial and the clan-based socio-organisational systems, especially during times of crisis. Colonial Ireland formed part of a large hierarchical bureaucracy that depended upon important decisions made in England and Europe that determined human activity and the interaction of the people with their local ecosystems they depended upon. Accordingly, when resources are scarce they are disproportionately kept by the elites during times of instability. Thus, these large and complex systems, as Tainter notes, become less capable to address problems from decision makers that are far removed from where problems had been developing. Additionally, as Van der Leeuw stressed in a society going toward environmental crisis, the lack of connectivity to the ecosystems that these large organisational structures that they ultimately depend upon is systematic as the local input into the decision making process is minimal. Therefore, local observations of the environment and the impact of human activities needs to go through different levels of authority thereby the decision makers lack first-hand accounts and experiences to address the coming environmental crisis. However, Gaelic, the king and elites in the clan-based organization depend upon the needs of those that support them for their power. Thus, during times of crisis there is a heightened emphasis upon distribution of needed resources to all of those in the clan and those that support the clan.

Additionally, this clan organizational system is more de-centralised and draws upon the observations and decisions of different members. Therefore, this system is better positioned to adapt to ecological changes that affect resources that is needed by the clan.

Chapter 6- An Interdisciplinary Study of Vulnerability & Resilience of the Irish Gaels and the Bedouin of the Mamluk Frontier in Comparison to their Settler Counterparts leading up to Black Death

I. Introduction

There is evidence that both the Bedouins and the Irish Gaels survived famine and Black Death of the mid-14th century better than their more relatively more sedentary neighbours (Borsch, 2005:51; DeWitte *et al.* 2016:2; DeWitte & Slavin, 2013:37; Ellis, 2006: 182; Hopley 2016; Richardson, 1947: 21). Both had enculturation movements, named *Bedouinisation* and *Gaelicisation* respectively, that led to cultural characteristics being adapted by more people leading up to Black Death and continuing well afterwards. This chapter explores whether these movements developed in response to vulnerabilities over defence, food security, and disease.

The centralisation of large bureaucracies in Europe and the Eastern Mediterranean increased with the onset of the Crusades, which brought much social organisational, economic, ecological/biological, demographic, and intellectual change with it. The Gaels and the Bedouin though under these centralised powers, were not as controlled by them. Both these peripheral groups had been characterised by their lack of defined way of life as both groups were involved along the spectrum from settlement agriculture to the mobile raiding herders. The relative adaptability of the more de-centralised Gaels and Bedouin allowed them to survive and expand in times of crisis, as during the Black Death.

The first section of this chapter, *The Obscure Revolutionaries of Black Death: The Medieval Bedouin and the Gaelic Expansion during Crisis*, focuses on who are the Medieval Irish Gaels and Bedouin of the Mamluk Frontier and what their experience leading up to and during Black Death had been in the context of being on the periphery of large, centralized socio-economic organizations as the Roman Church, England, and the Mamluk Empire.

The following segment, *The Centralisation of Hierarchical Powers over Economy, Society, and Thought*, illustrates the context that the Mamluk, English, and the

Roman Church powers transformed the societal organization, economy, landscape and thought of most of the people they ruled over. The Crusades is a large focus here as it is thought to have been a transformative event for the centralization of powers in Afro-Eurasia. This section initially focuses upon Levant and Egypt, but then addresses the Crusades and the attacks on heretics within Europe. The importance of the augmentation and centralization of power and wealth of the Roman Church is highlighted here as a continent was united under its administration and the standardization of international law, trade, politics, and knowledge is where its authority was undisputed. The transformation of education and the augmentation of the size and complexity of bureaucracies are seen in the Church, as well as English and Mamluk realms. The priority on the growth of wealth increased in urgency in the context of insecurity both from foreign powers as well as internal disruption, that the Bedouin and the Gaels frequently provided.

The last section, *Deciphering Resilience and Vulnerability for the mid-Fourteenth Century Plague in Europe and the Southeast Mediterranean*, highlights the potential to adapt in different socio-economic systems. The dynamics associated with the give-and-take of agricultural settlements and herding is illustrated through Angourakis *et al.*'s *Musical Chairs* model. Bedouin and Gaelic networking, organizational, and economic systems is analyzed as well as systems of cognition that focus much attention to environmental and societal sustainability. The carrying capacity of grasslands and the distribution of resources within clan/tribal networks are thought to be similar between both the Bedouin and the Gaels, while some differences seem to be present with networking and organizational systems.

The *Discussion* then assesses the vulnerability and resilience of the Bedouin and the Gaels as well as the settler counterparts that were living within the Mamluk, and English colony in Ireland (who were also under the power of the Roman Church) through the previous mentioned Table 1 inquiry points and the factors of vulnerability for a zoonotic epidemic (Begon and McMichael) and der Leeuw's *What drives socio-environmental systems regularly towards a crisis?* and Tainter's *four concepts that lead to understanding collapse*.

II. The Obscure Revolutionaries of Black Death: The Medieval Bedouin & the Gaelic Expansion during Crisis

6.1 Who were the Medieval Irish Gaels and the Bedouins of the Mamluk Frontier?

Ibn Khaldūn described the *badw* (Bedouin) as “those who either live from cultivation of the land (*al-falh*) or those who make their living by raising livestock.” (Rapoport, 2004:3). Those that cultivated the land were by far the majority of people in the Middle Ages and when food security diminished with agriculture, many peasants of Egypt and the Levant became herders. The Irish Gaels, as the Bedouin were also often difficult to distinguish from their colonial counterparts (some of whom have only known Ireland) to such a degree that King Edward III enacted statutes in 1366A.D. that forbade the English to have influence from and connection to the Irish. Article 2 of that statute stated:

...it is ordained and established, that no alliance by marriage, gossiped, fostering of children, concubinage or by amour, nor in any other manner, be henceforth made between the English and Irish of one part, or of the other part; and that no Englishman, nor other person, being at peace, do give or sell to any Irishman, in time of peace or war, horses or armour, nor any manner of victuals in time of war; and if any shall do to the contrary, and thereof be attainted, he shall have judgment of life and member, as a traitor to our lord the king. (Statutes of Kilkenny, 1366)

Both the Gaels and the Bedouin have been greatly demeaned in the historic record, and were largely stereotyped as herders that were continuously at war and often raided settlement areas. However, the Gaels and the Bedouin were two groups that are very difficult to define in that they cannot be tied to any particular way of life and they are often indistinguishable with their neighbours. A great population of Gaels and Bedouin were settlers, some on a temporary basis and others seemingly permanently, some were mercenaries who would form alliances for short-term benefits (but when the benefits ran out so might the alliance), some were herders (many of whom may have raided nearby settlements). None of these ways of life of the Gaels and the Bedouin are mutually exclusive, and even if particular individuals did a particular economic activity throughout their lifetime, they knew they could make a living in a different way. This flexibility and adaptability that makes the medieval Gaels

and Bedouin difficult to define is indeed what largely defines them. During times of crisis in the late thirteenth/fourteenth century an Irish process of “Gaelicisation” and in the Mamluk Empire “Bedouinisation” is said to have taken place where the influence of these groups are seen on settled populations outside of their groups. This made it increasingly difficult to distinguish a non-Gael or a non-Bedouin from one native to these cultural groups. Yet, it is the Gaels and the Bedouins that augmented their territory and are cited in the historical records as surviving especially well during famine and the Black Death.

6.2 The Experience of the Gaels and Bedouins during Black Death

Both the Gaels and the Bedouin should not be labeled as having a way of life under a particular socio-economic system. However, it was in fact the spectrum that was had within these groups from an agricultural cash-crop settlement-based economy, to a very mobile, trading, militaristic group that gave them increased flexibility and adaptability relative to the agricultural settlement populations they lived in close proximity to. Additionally, both the Irish Sea area Gaels and the Bedouins were believed to have survived famine and Black Death much more effectively and expanded their territories accordingly. An example of this is the increased raiding threat the Bedouins were to the rural population, which became especially pronounced during the Plague years, which led many peasants to abandon their lands. Additionally, the Mamluk authorities demanded disarmament in the rural regions of the Empire, largely leaving the agrarian villages defenceless in the fourteenth and fifteenth centuries. Thus, the Bedouin presence expanded over much of rural Mamluk lands (Borsch, 2005:51). The rural agricultural communities that the Bedouins disrupted or took over would have provided tax income for governments and cereals to the cities. Thus, the Bedouins would have become a major disrupting force for the region. Accordingly, during the Plague the ability of the economic, political and social organisational institutions to stand often reached the breaking point, as Ibn Khaldūn observed,

At the present time- that is, at the end of the eighth [i.e. fourteenth] century – the situation in North Africa, as we can observe, has taken a turn and changed entirely. The Berbers, the original population of North Africa, have been replaced by an influx of Arab Bedouin. The Bedouin

outnumbered and overpowered the Berbers of North Africa, stripped them of most of their land, and also seized the lion's share of those lands that remained in their possession. This was the situation until, the middle of the fourteenth century, civilization in both the east and the west was visited by a destructive plague which devastated nations and caused populations to vanish. It swallowed up many of the good things of civilization and obliterated them. It overtook dynasties at the time of their senility, when they had reached the limit of their duration. It lessened their power and curtailed their influence. It weakened their authority. Their situation approached the point of annihilation and dissolution. Civilization in the land decreased with the decrease of humanity. Great cities and monuments were laid waste, roads and way signs were obliterated, settlements and mansions became empty, and tribes grew weak. Indeed, the entire inhabited world changed. It was as if the voice of existence had called out for oblivion, and the world had responded to its call. (Hopley 2016: 178-179)

The Bedouin expansion also led to greater Bedouin influence and power, which also led to some of the peasantry to join them. This "Bedouinisation" movement is not unique. A very similar phenomena was happening in the mid-fourteenth century Ireland where the Gaels threatened the agriculturalists of the English colony and their ecclesiastical allies. The petition to King Edward III of England from the Dublin Parliament in 1360 stated "...the Pestilence which was so great and so hideous among the English lieges, and not among the Irish...that the land and the lieges are so enfeebled by the said enemies that they can nowhere be defended nor protected, as formerly, save by the presence of your said justiciar." (Richardson, 1947: 21). Archbishop FitzRalph of Armagh had a similar call for help when he preached before the Pope at Avignon in August 1349, stating that the plague killed more than two-thirds of the English, but did not affect the Irish or Scottish (Ellis, 2006: 182). However, even before the Bruce Invasion (1315-1318) there had been an increasing amount of colonists joining the Gaelic ranks, to a degree that King Edward III enacted the 1367 statute, noted earlier, that forbid this mixing, not only through marriage, but also in their physical appearance. However, just as the Bedouins and the peasantry in the rural Mamluk territories, there was often a blurring dividing line with the Gaels of Ireland and their English colonists as marriages and socio-economic characteristics became quite blended in rural areas.

Might have these “Bedouinisation” and “Gaelicisation” phenomena been, at least in part, the result of a greater the greater adaptability that the people of these alternative socio-economic systems possessed? William and Fidelity Lancaster (1988: 52) paraphrased Ibn Khaldūn in illustrating his belief in that the Bedouin’s adaptability to their natural and social environments ruled the period, [Ibn Khaldūn]...sees the Bedouin and the towns of the Arab world (as Gellner puts it) in terns of Plato’s sheep, wolves and sheep-dogs. The Bedouin (the wolves) supply the towns (the sheep) with rulers (when the wolves become sheep-dogs) until the urbanised Bedouin become sheep in their turn and more Bedouin come out of the desert to start the cycle again. This view, which places emphasis on the moral superiority of the Bedouin, nevertheless assumes that the Bedouin are predatory because of their harsh environment; indeed, Ibn Khaldūn bases the superior moral virtues of the Bedouin on the harshness of their surroundings, apparently finding morals determined by ecology.

Though Ibn Khaldūn is certainly generalising here, but it is true that the Bedouin more than any other people were likely more aware of the conditions of agricultural settlement, grazing lands, trade, and military circumstances of potential alliances and opposing forces as they were intimately part of all these ways of life. Thus, they would have been in a better position to manipulate others due to this more comprehensive knowledge. Agricultural rural settlements were siting targets for Bedouin raids, as the manors also were in Ireland, leading to a great deal of insecurity and uncertainty of their future well-being. Additionally, the Mamluks were sustaining wars with the Crusaders, the Mongols and then the Bedouins and others to stay in power, which depended upon taxes, horses and camels, as well as agricultural surpluses to continue. Similarly, the English were supporting the Hundred Year’s War with Scotland, which had been increasing the tax burden on the people, as Slavin illustrates,

...the (English) Crown’s expenses increased from between £40,000 to £70,000 in c. 1300 to an average of roughly £200,000 in the 1320’s. The Hundred Years War created financial crisis on crisis. In all, the war cost England a million pounds, mostly paid for out of the cloth and wool exports, which created a balance of payments problem (Slavin, 2010:32).

The Mamluk and English Empires (Gilchrist, 1969:19) were in the midst of instability and struggling to secure their empires, while the Bedouin and Gaels were seeing a resurgence and expanding their territory. The vulnerability and resilience of socio-economic systems and to zoonotic disease, as Black Death, seemingly play crucial roles in developing these disparities and consequently will be the focus of this chapter.

6.3 The Crusade Invasions and the Development of a Centralised Levant & Egyptian State

As noted in chapter 1, the first European economic union had been formed by the Church, which drew together the north and the south, as well as many of those of the frontier, as Ireland, for the first time. The uniting force was not the kings, but the ecclesiastical hierarchy that was headed by Pope with his centralised, bureaucratic hierarchy in Rome. The authority the Church held had been especially vivid in its organisation of the Crusades, which led to thousands of men leaving their countries to fight under the Church's flag. This undertaking gave the Church the power to unite the continent over and above any national boundaries. The Church became the centre of the moral authority, as well as political and economic realms as no secular power had the force and authority to mount a significant opposition. Those that did oppose risked being called a heretic, which gave the institution the right to use any means necessary to put down this unholy threat. The Church's authority and the Crusades also lead to economic expansion for resources, as Aleksander Pluskowski, Adrian J. Boas, and Christopher Gerrard illustrated,

...while the character, chronology and cultural impact of the crusading movement in different regions could vary quite dramatically, in all cases it was accompanied by a process of colonisation. This impulse was not peculiar to the frontiers of Christendom; in fact, colonisation characterised a fundamental aspect of European societies from the 11th to 13th centuries AD. The expansion and movement of European populations was closely tied to the increasing exploitation of natural resources. This was more than just an economic or demographic expansion, however; the centuries of the medieval warm period saw a new definition of the human ecological niche. People aspired to manipulate their local environments to suit their changing socio-economic and ideological requirements, a tendency that was most pronounced in colonised regions. An ecological perspective in this context focuses on environmental transformation arising from changing patterns

of human activity, resulting in the creation of new ecological niches (Pluskowski *et al.*, 2011:225).

The focus of the Crusades was to support a centralised Christianity, similar to what was seen almost a millennium earlier under the Roman Emperor Constantine. Therefore, those that opposed this centralised economy was an area of focus for the Crusades whether it was Ireland, the Baltic States, or Muslims ruling over the Holy Land. The late eleventh century attack of the Holy Land in the late eleventh century had been against a unified opposition of small Islamic states and their tribal allies. The fear of the consequences of disunity was something Sultan Saladin was tapping into after Damascus alone attempted to pay the Crusaders for peace in 1174A.D. It was under this reasoning that Saladin invaded and took power of Damascus and continued to stomp out opposition to unify Islam. He remarked that his opponents in the city of Homs (Syria) “had become enemies, preventing the accomplishment of our purpose with regard to the war [against the Christians]” (Davenport 2003: 42)

Though the earlier Muslim fighting forces were very effective on raids and quick attacks they did not have sufficient forces or infrastructure to defend the Holy Land. These forces also had a history of fighting against each other and it was not until Salah al-Din established the Ayyubid Dynasty that a more unified front began to be organised (Walker, 1999:202). This is exemplified in the pollen diagram below of the Antioch on the coast of Syria, which shows the distinction of early-Arab-Islamic presence to the much more united pollen record from the Crusades through to the Mamluk period.

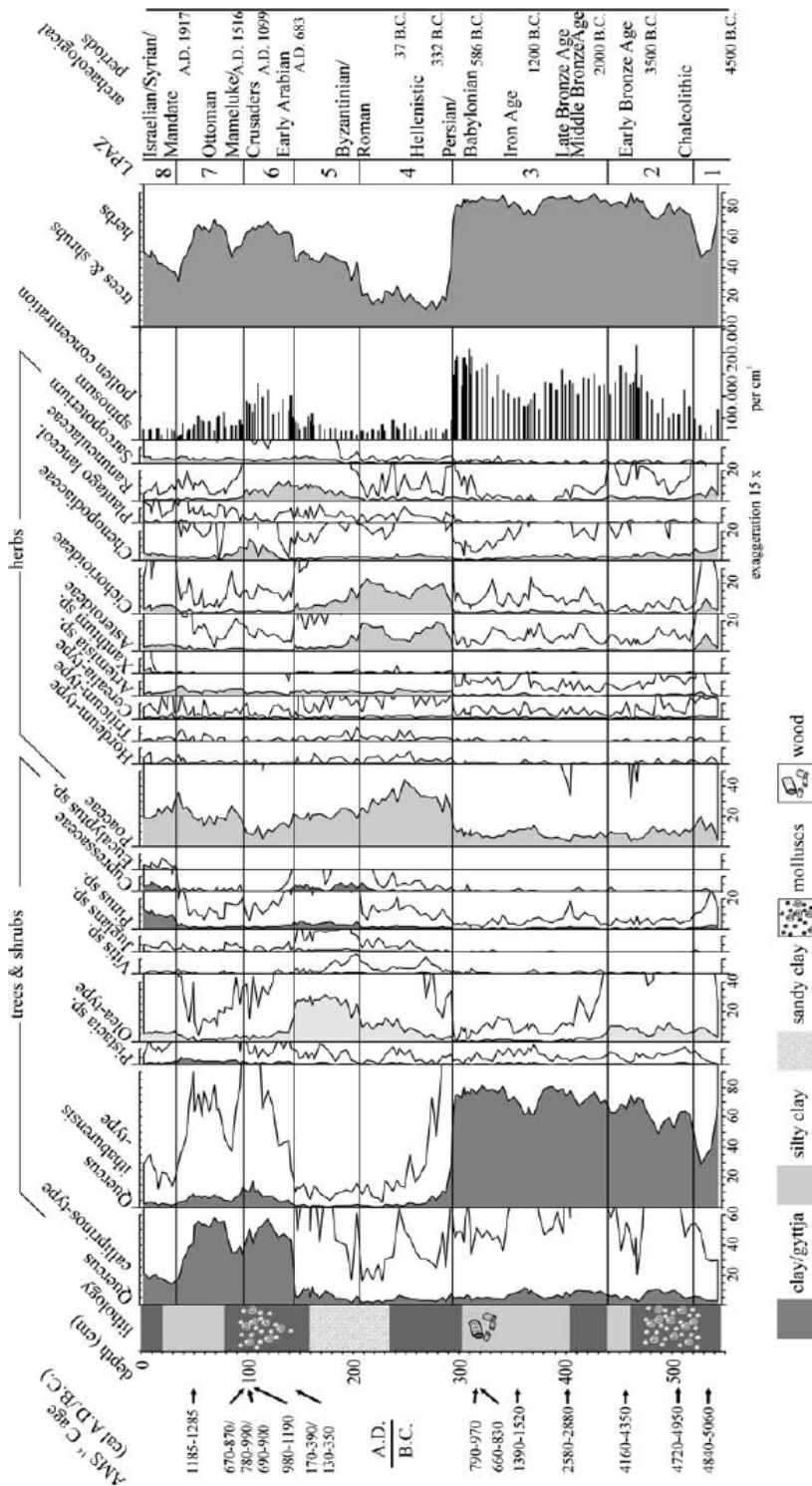


Fig. 6.1. Pollen Diagram of Antioch, Syria: They observe, “The strong decrease of arbori-, horti- and agriculture, and the disappearance of *Vitis vinifera* at the end of the crusader period are mainly linked with a cultural change brought by the rise of the Mamelukes in the Levant. The Mamelukes developed a new agro-production (Behrens-Abouseif, 2008), based on pastoral activities and crop cultivation (cereals) around Jableh.” (Kaniewski, *et. al.* 2010:260)

Kaniewski *et al.*(2010) in the diagram illustrate the decline of pollen concentration and trees and shrubs from the Crusade period to the Mamluk times, both of which signal deforestation and clearance, leading to less concentration and biodiversity of vegetation. Additionally, the increase in Poaceae indicates the greater emphasis upon herding, while the presence of cereals increased from the middle of the Crusade period, although declining somewhat in the Mamluk period.

Once Ayyubid and the later Mamluk dynasties took over the Holy Land, the infrastructure that the Christian invaders left became not only part of their economic system and physical defence, but led to further re-structuring and centralisation of authority. The ability to develop quick economic surpluses through the trade of commodities of high international market demand further solidified the foundation for the Mamluk dynastic state to continue to grow economically. The standardisation of markets in a trading economy lead to cultivating the same species or closely related species (i.e. wheat, sheep, and cattle) throughout a trading region, creating “similar socio-economic conditions” within the economic zone. These similar socio-economic conditions would have been heightened by the common European practice of domestic animals staying under the same roof as peasants and agricultural labourers (Pluskowski, Boas, and Gerrard 2011:192-225), while wildlife adapted to ecological services that resulted from human impact (e.g. rodents with cereal cultivation) and the increased demand for intensive labour, leading to greater human population densities. This growth also demanded the expansion of literacy to address issues of law and administration of this centralised bureaucracy. This change in educational emphasis began in the late Ayyubid dynasty, but was especially seen in the Mamluk period, propelling the fields of medicine and *madrasah*-style lectures, which included hadith (statements and actions of the Prophet Muhammad), *fiqh* (Islamic law and the teachings of the Prophet), Arabic literature, philosophy (Walker, 2011:47-48). Gilbert demonstrates this focus on the training of bureaucrats in the Ayyubid and Mamluk governments in the establishment of *madrasas* in Damascus in the chart below:

Table 6.1. Madrasas Established in Damascus, 468/1076-658/1260 (Gilbert, 1980:115).

		Inside City Walls		Suburbs				
		Located within the Great Mosque	Other locations	Sharaf	'Uqayba	Outside Bāb Tama	Ṣālbiyya	Kurdish quarter
A. D.	A. H.							
1076	468-479	1						
	480-489							
1100	490-499		1					
	500-509							
	510-519		1					
	520-529		3	1				
	530-539		1					
1150	540-549		3					
	550-559		3					
	560-569	1	4	1				
	570-579	1	4	1				
	580-589		4					
	590-599		6				1	
1200	600-609		1	1			2	
	610-619		3		1			
	620-629		3	2			8	1
	630-639		5			3	2	
	640-649	1	4				1	
1260	650-658	1	5				2	

It is noteworthy that the first *madrasas* was established within the Great Mosque of Damascus at the end of the eleventh century with substantial developments of other *madrasas* in other locations in the city in the twelfth century, and further out in the suburbs in the thirteenth century. Gilbert (1980: 115) also observed that,

...between the years 468/1076 and 658/1260 one hundred and twenty-one new religious institutions were established, and there were over four hundred new job openings and turnovers in professorships and shaykhships at this institutions...Biographies report the specific types and locations of the hundreds of professional posts now occupied by legal scholars, muhaddiths, and sūfis in Damascus [See chart below].

Table 6.2. New Religious Establishments in Damascus and Turnovers in Professorships and Shaykhships, 468/1076-658/1260 (Gilbert, 1980:119).

Type of Building	No. Buildings	No. Job Turnovers
Shāfi'i madrasa.....	34	145
Ḥanafī madrasa.....	35	165
combined Shāfi'i-Ḥanafī madrasa.....	4	25
Ḥanballī madrasa.....	9	40
Mālikī madrasa.....	3	7
dār al-ḥadīth.....	7	14
dār al-ḥadīths within 2 Ḥanballī madrasas and 1 Ḥanafī madrasa.....	3	3
khānaqāh.....	11	8
ribāṭ.....	7	2
rāwīqā.....	8	13
TOTAL.....	121	422

This transfer of knowledge through these institutions may have indeed laid the intellectual foundation for a greater re-structuring of the economy to take hold. According to B.J. Walker, the Ayyubids *iqṭā'* system held an especially important role in the Mamluk economy. Professor Walker explains how this system functioned,

Salāh al-Dīn used *iqṭā'* assignments, the granting of tax revenues in exchange for military or administrative service, to bolster his authority among his kinsfolk, officials, and army in newly conquered territories, which thus made them critical to maintaining the Ayyubid order. The recipients of such grants were expected to perform a variety of duties (*khidmah*) for the state, including military service, attending the sultan's banquets (*ṣimāṭs*) when summoned, and building and maintaining public facilities (most importantly, fortifications and waterworks), tasks that continued into the Mamluk period. The emphasis of this system was on security: *iqṭā'āt* were awarded to the '*urbān* ("*iqṭā'āt* of reliance," as they are described by Bundārī), in order to keep the tribesmen out of the villages and towns and render them useful to the state by providing information on borders and roads, refraining from pillaging and killing, and equipping the Ayyubid armies with camels during military campaigns (Walker, 2011:49-50).

Walker also noted that it was under the Ayyubids that "the majority of agricultural land in Syria and Egypt was allotted as military y *iqṭā'āt* and administered by local personnel, often the *muqṭa'* (a government officer)

himself" (Walker, 2011:50). The *iqtā'* system allowed the state to augment its wealth while also increasing the centralised control and security of the region. The Mamluks continued this system to help expand its territory and achieve temporary political stability "through the central government's manipulation of agrarian administration in the region,... shifting borders and district capitals allowed the sultan to co-opt local tribes, manipulate their alliances, and attempt to quell amiral rebellions" (Walker, 2014:36).

The agrarian administration of the farmland was used to support the Mamluk military through the *iqtā'āt* (quasi-feudal tax grants) (Walker, 2014:36). The most fertile land was often saved for the state monopoly, the sugar industry, which was especially profitable and a main cash-crop export (Walker, 2014:36). These Mamluk frontier regions, as present-day Jordan, not only provided the central government in Cairo with cash through trade, agricultural commodities, but also horses for the cavalry (Walker, 2014:36). This is all part of the rural organisation of what J.L. Abu-Lughod refers to as the "military-industrial complex" that helped the Levant region repel the Crusaders and in doing so, developed a similar centralised economic system (Abu-Lughod, 1991:230).

6.4 The Crusades and the Attacks of Heretics in Europe, an Economic Issue?

The Case of Ireland

The Crusades are represented as a religious war of Christians against Muslims. However, the Crusades continued in Europe where there were no Muslims to be found, against peoples labeled as pagans or heretics. Ireland is an especially interesting case as Irish monasteries were among the most influential in Europe in the early Middle Ages. Converting Ireland to centralized Roman Christianity was the reason for harsh actions against the island. The problem for the Roman Church was about the Irish organisational structure and an economic system that was largely local or regional in scope. This Irish system of local (clan) control of people and available resources led to limited influence from Rome and limited growth in wealth for the Church and its supporters. There was also the predatory interest of a more economically centralised neighbour (England, which saw unexploited economic potential in Ireland, and the opportunity to win

territory for land hungry aristocrats. These varying motives may be seen in part of King Henry I of England's Charter of Liberties (1100A.D.):

Know that by the mercy of God and the common counsel of the barons of the whole kingdom of England I have been crowned king of said kingdom; and because the kingdom had been oppressed by unjust exactions, I, through fear of God and the love which I have toward you all, in the first place make the holy church of God free, so that I will neither sell nor put to farm, nor on the death of archbishop or bishop or abbot will I take anything from the church's demesne or from its men until the successor shall enter it. (Davies, 1997)

Henry I and other European leaders knew they had to appease the Church in order to grow their power and therefore gave the Church economic backing as well as military support. This speaks to the centralisation of power that the Church desired that Ireland was not substantially contributing to before the mid-twelfth century. However, powerful kings of Europe did not desire to do the Church's bidding, which led to clashes, as Henry I had with the Archbishop of Canterbury Anselm of Bec where Henry threatened him with a ban from England and the archbishop threatened the king with excommunication (Hopkins 2002: 139), which would have greatly diminished his legitimacy to continue holding his office. The Church had the right to question even the private actions of kings, and this had weight as the throne of kings in Europe were sanctified by the Church, which could also be withdrawn in favour of another who sought the office. Although kings could manipulate more independence and power from the Church, especially during times of disorder and weakness as was heightened by the Investiture Controversy, no king held such to so easily de-legitimise the Pope, at least until around the beginning of the fourteenth century with the Avignon Papacy (1309-1376) (Para 2016:1-16). This change of the seat of the Papacy certainly signified the weakened authority and power of the Church that greatly diminished its capacity as a centralized organization to address pressing problems. Similarly, kings that were not supported by the Church would have been undermined and thereby the king would struggle to maintain his rule. Both kings and the Pope depended upon supportive networks that legitimised their rule, without which they would have a weak rule, if any at all, while socio-economic and ecological issues would potentially grow and with little possibility of addressing them.

Ireland, in contrast to the Roman Church and the English Kingdom, was a land of clans and clan networks. The churches were under local control and their economies and the demands of the people were quite regional in nature. This did not bode well for secular and ecclesiastical hierarchy that wanted to augment their power and influence. The Irish churches had a level of independence and they were not increasing Rome's wealth. An excerpt in the Annals of Ulster exemplifies this clash of cultural and economic expectations in 1224 A.D.,

Cathal Red-Hand Ua Conchobair, king of Connacht and king of the Gaidhil of Ireland for ability, died in the Cistercian Monastery of Cnoc-Muaidhe, on the 5th of the Kalends of June....The best Gaidhel that came from Brian Boruma down, for nobleness and for honour; very fortunate and capable preserver of his territories; wealthy, well-disposed, excellent auxiliary of peace. Seems it is in his time tithe was had legally for the first time in Ireland. Fitting, pious, right-judging prop of faith and christianity; punisher of the guilty and of outlaws; destroyer of robbers and of evil-doers; general battle-victorious maintainer of the righteous law. To whom God gave good honour on earth and the heavenly kingdom beyond. He died in the habit of a Cistercian monk, after bringing victory from the world and from the demon (Bambury, 2000).

The belief that the first legitimate tithe of Ireland (or a sizable tithe being collected on a regular basis) occurred not much before 1224A.D. shows the resistance to this financial fund raising for the Church. Ireland was an economy that thrived on local trade often through bartering, its secular and ecclesiastical elites were not accumulating much wealth compared to their English counterparts, with sometimes stark differences. Flanagan (2010: 88-89) explains some reasons behind this common complaint that some mother churches in Ireland were giving insufficient tithes,

Archbishop John Cumin's provincial synod of 1189 decreed that Mass was not to be celebrated in chapels constructed by laymen to the injury of mother-churches without the permission of the bishop of the diocese and the pastor of the mother-church, in line with practice elsewhere. Charges of non-payment of tithes can be interpreted in a number of ways. Tithes may have been appropriated by local lay lords, as may be suggested by the second decree of synod of Cashel (1101). That tithes were not being paid punctually ...is the emphasis of the annalistic entry in

the Annals of the Four Masters concerning the synod of Kells (1152). The third decree of the council of Cashel (1171/2), could be read as indicating not that tithes were not being paid but rather they were not going to the appropriate parochial church.

The relative lack of funding of the Irish churches and for many tithes potentially going to local lords instead of the local pastor and/or the diocesan bishop was certainly something the Church would have wanted to stop as quickly as possible. It is debatable to what degree this influenced Popes Adrian IV and Alexander III to support the English invasion of Ireland, but certainly the archbishops of Canterbury were keen on the change. As Downham explained, “successive archbishops of Canterbury sought to claim authority over the Irish Church... bishops were consecrated by successive archbishops of Canterbury in 1074 and 1085, 1096, and 1121” (Downham, 2017: 212). Downham also points out that after King Stephen (1135-1154) failed to successfully influence the Pope to have the Dublin brought under English ecclesiastical control, “the English Church sought papal sanction for military intervention in Ireland...” (Downham, 2017: 212). The English Pope, Adrian IV, would grant that request through the papal bull, *Laudabiliter* (in 1155), though only years later in 1171 did King Henry invade Ireland. Adrian IV’s focus upon increasing the power of the Church, under the right of the Gregorian Reforms is repeated and highlighted in different ways. Adrian’s authority is again highlighted in stating,

...that Ireland, and all the ...lands upon which Christ the Sun of Justice has shone, and which have received the knowledge of Christian faith, are subject to the authority of St. Peter and of the most Holy Roman Church. Wherefore we are the more desirous to sow in them an acceptable seed and a plantation pleasing unto God, because we know that a most rigorous account of them shall be required of us hereafter (McCormick and Waldteufel, 1889:27).

This authority is also followed by the legal and financial support of the Church. Adrian basically reiterates a leasing agreement with Henry II by stating that the crown must pay the Holy See a penny for every household. The Pope writes,

...you have signified to us that you propose to enter the island of Ireland to establish the observance of law among its people, and to eradicate the weeds of vice; and that you are willing to pay from every house one penny

as an annual tribute to St. Peter, and to preserve the rights of the churches of that land, whole and inviolate (McCormick and Waldteufel, 1889:27).

This Papal letter shows his focus upon increasing control of the Irish Church and centralising this control with the office of the Holy See. The pushing of Ireland to a cash-based trading economy is also seen in the prerequisite of a penny tax per household (which is repeated a couple times in the letter) (McCormick and Waldteufel, 1889:27). These authoritative policies that *Laudabiliter* advocated for were also referenced and acted upon by the next Pope, Alexander III.

After the English invasion, the ownership of ecclesiastical lands in the colony changed. These were placed under the control of their respective bishops, and often resulting in the “complete disappearance of former occupiers, the coarbs and erenaghs and their clans, and the other quasi-ecclesiastical clans associated with these establishments” (Nicholls, 1972: 112). Accordingly, these ecclesiastic centres in Ireland had become organised to become more hierarchical and centralised, thereby giving the Pope and the international orders more centralised control. The authority of the Church was exemplified by Pope Innocent III’s *Decreto Venerabilem*, which was written to the Duke of Zähringen to justify his intervention in secular leadership:

... We [the Church] acknowledge, as we are bound, that the right and authority to elect a king (later to be elevated to the Imperial throne) belongs to those princes to whom it is known to belong by right and ancient custom; especially as this right and authority came to them from the Apostolic See, which transferred the Empire from the Greeks to the Germans in the person of Charles the Great. But the princes should recognize, and assuredly do recognize, that the right and authority to examine the person so elected king (to be elevated to the Empire) belongs to us who anoint, consecrate and crown him. For it is a generally observed rule that the examination of a person belongs to him who has the duty of the laying-on of hands. For suppose that the princes elected a sacrilegious man or an excommunicate, a tyrant or an imbecile, a heretic or a pagan; and that not just by a majority, but unanimously, are we bound to anoint, consecrate and crown such a person? Of course not. ...

And it is evident from law and custom that when in an election the votes of the princes are divided we may, after due warning and a fitting interval, favour one of the parties. ... For if after such due notice the princes cannot or will not agree, will not the Apostolic See be without an advocate and

defender, and thus be punished for their fault? (Bettenson and Maunder, 2011:123-4).

Innocent III here proclaimed that the Church had the right to intervene if a king was elected that it did not like. This statement should be understood in the context that the Church held not only ideological power, but the Church had canon courts around Europe to re-enforce this power. These court towns also became centres of legal schools that the Church's universities, as Oxford and Cambridge were born from. The Church uniquely trained future officials in law and administration. As international trade blossomed the Church was in the unique position to administer this economy.

Similar phenomena took place in the fourteenth (eighth) century Mamluk cites, where Islamic law schools (*madrasas*) may have quickly developed to help address the financial and political insecurity in Cairo in order to assist officers "to protect their assets from confiscation" (Walker, 2007:120). Walker (2007) continues this assessment in summarising the effect these *madrasas* and the private owed estates (*amlak*) were having on the Jordan Valley in noting the "Mamluk rural policies in this region were largely political motivated [and did not consider what was best for the local markets] for the long term for the environment" (Walker, 2007:120). Thus, the administrators of the wealth in the Mamluk Empire, as well as Church and its wealth producing orders, such as the Cistercians, and the nations under the Church's umbrella, were the benefactors of this wealth generation.

The growth of English influence had the backing of some opportunistic Irish rulers, or aspiring rulers, as well as some clerics (though some may have wanted more reform within Irish churches). Thus, the English and the continental Church quickly became prominent and dominant in the areas colonised by the English, especially around Dublin. Dublin became the increasingly important trading hub as well as the centre of the continental Church and English influence in Ireland. However, some of the most profound changes may have taken place in rural Ireland. In order for Ireland to be a trading economy, it had to develop greater specializations, larger scale production, and a cash-based economy. The

frustration of this economic change and the taxes that went with it led the Irish regional kings to write Pope John XXII,

...Pope Adrian, your predecessor, an Englishman not so much by birth as by feeling and character, did in fact, but unfairly, confer upon that ...(King) Henry... this lordship of ours by a certain form of words, the course of justice entirely disregarded and the moral vision of that great pontiff blinded, alas! by his English proclivities. And thus, without fault of ours and without reasonable cause, he stripped us of our royal honour and gave us over to be rent by teeth more cruel than any beast's; and those of us that escaped half-alive and woefully from the deadly teeth of crafty foxes and greedy wolves were thrown by violence into a gulf of doleful slavery. (Ó Néill, 2010:39)

The taxes that were put upon these Irish kings forced them to either be part of the colonial economy (as they needed to be able to create enough commodities with a high market valued to be able pay the taxes and provide life necessities) or move to areas that were not deemed beneficial for agriculture and take a safe haven there. The English and the Church had no problem pushing aside issues the Irish proclaimed in order to promote an economy constructed for wealth-building through the English “urban” economic development zones to foster growth of British settlement and entrepreneurship by giving away land in Ireland with a promise of a local monopoly in what the new foreign entrepreneurs produced there, (Bartlett 1994:118) as well as the great expansion of the Church’s disciplined orders, as the Cistercians that lived sparsely while generating great wealth by transforming landscapes to agriculture. Though these development zones and monastic manors were in part meant to urbanize and centralise the rural economies to be dependent upon foreign markets and thereby under the greater control of those that regulated and administered the national and international economy. Accordingly, much of Ireland became more of a continental-looking countryside, which was increasingly integration into the wider European process of economic expansion. People progressively began to distance themselves from their local ecologies and the cooperation of local networks to get what they needed, and progressively depended upon the trading economy for their livelihood. Southern summarises the socio-economic changes going into the twelfth century:

...within the next sixty or seventy years (from 1050A.D.) the outlook had changed in almost every respect. The secular ruler had been demoted from his position of quasi-sacerdotal splendor, the pope had assumed a new power of intervention and direction in both spiritual and secular affairs, the Benedictine Rule had lost its monopoly in the religious life, an entirely new impulse had been given to law and theology, and several important steps had been taken towards understanding and even controlling the physical world. The expansion of Europe had begun in earnest. That all this should have happened in so short a time is most remarkable fact in medieval history. (Southern, 1970:34)

As the twelfth century continued the cycle of vicious economic growth, organizational expansion, and the expansion of dependency upon the socio-economic systems that fostered trade and the rapid building of wealth, led to the extension of agricultural cultivation on new lands as people were anxious to get a part of this new economy. There was optimism that led to risks not seen in previous generations. This was not a socio-economic change based upon technological innovation, but rather, as Southern notes, "a combination of many circumstances: growing accumulation of capital, rising population, the return of Mediterranean to western control, the political decline of the Greek and Muslim empires, all helped to open up ever-enlarging prospects to the West"(Southern, 1970:34-35). The opportunity for centralisation of power expanded through Europe and beyond in the eyes of the Church. The European laity's confidence in and embrace of a new reality of hope of a better life through the guidance of the Church was promising to bring a surplus of wealth to a degree that had not been seen before. Southern elaborates on this new, perceived reality of the twelfth century:

When it had once started the expansion became irresistible. Increasing rewards encouraged the settlement of waste lands, the improvement of rivers, roads, and canals, the introduction of new methods of farming, the organization of markets and credit. All over northern Europe we find new villages where previously there had been only waste-land. The contraction of urban population, which had marked the end of the Roman Empire and remained a feature of the first period of medieval history, was now decisively reversed. Colonization began on all the frontiers of western Europe, and with colonization there began the familiar process of military aggression. For the first time in its history western Europe became an area of surplus population and surplus productivity, and it developed all the assertive and aggressive tendencies of a rapidly and

self-confident community. An active and bloodthirsty sense of superiority took the place of the fear and resentment towards the outside world which had characterized the earlier period...For two centuries after 1100 the West was in the grip of an urge for power and mastery to which there appeared no obvious limit. (Southern, 1970: 35)

This socio-economic expansion was changing the landscape in order to cultivate the land, for roads, the enlargement of villages and towns, the construction of ponds for fish farms, the construction of bridges, castles, and mills, to name a few projects of the period. In Norman England this change is exemplified in the establishment of water mills. Domesday Book records the existence of six thousand or more of them by 1086 (Southern, 1970: 27-28).

6.5 The Crusades and the Socio-Economic Transformation of Europe and the Eastern Mediterranean

The advent of the Crusades necessitated larger-scale developments in the Levant and Egypt also, as the sugar industry (which the Franks expanded largely through the Hospitaller Order along the Mediterranean coast and in the Jordan Valley) (Pluskowski, Boas, and Gerrard, 2011:119), which was especially profitable and had been cultivated on the Sultan's best lands, castle building, infrastructure projects, expansion of urban areas, and the giving of lands to military officers based on the agreement on their service (just as it was established in Europe). Jones *et al.* illustrate the archaeological change in regions of the Levant during the Middle Islamic period,

In the northern 'Araba and southern aghwar (plural of ghawr, Arabic for "lowland" or "valley"), settlement in villages increased during the Middle Islamic period, compared with the preceding Early Islamic... To the south, in the region west of Petra, survey has found similar patterns. Little settlement is evident in the Early Islamic period, but in the Middle Islamic, villages were built in defensible locations and, perhaps, mostly abandoned again before the beginning of the Late Islamic period... The plateau to the south of Petra also shows similar patterns, with little evidence for Byzantine and Early Islamic settlement, followed by an increase in settlement starting in the Middle Islamic. (Jones, Levy and Najjar, 2012:70)

The regeneration of this large-scale economy needed more production equipment and infrastructure to keep expanding this trading economy. The

wealth to undertake these projects was largely done through tax revenue, and the means of taxing needed to be established through ownership and in England that was recorded in the Domesday Book and in charters and in southern Syria it was called the *Rawk* (1313-1325A.D.), which was the basis for allocating estates (*iqta'at*) to military officers (Walker 2007:119-120). This recording of wealth was crucial for augmenting tax revenue in that it allowed these governments to know approximately how hard they could push individuals under their power to be required to give.

The growing trading economy increased demand for specialized skills, such as the reading and writing of Latin and Arabic, law, as well as accountancy. Additionally, the expanding economy led to an increasingly larger, more complex bureaucracy in both secular and papal institutions, as they would have struggled to keep up with addressing the mounting needs to keep the economy growing. Evidence of this may be seen in the number of surviving Papal letters sent out from the eleventh to the fourteenth century:

...the annual average of surviving papal letters falls in the first half of the eleventh century from ten a year under Silvester II (999-1003) to only one a year under Benedict (1033-1046). Then the average rises under Leo IX to thirty-five and remains around this level until about 1130. Thereafter a swift and prolonged increase begins: and annual average of seventy-two under Innocent II (1130-1143), 130 under Adrian IV (1154-1159), 179 under Alexander III (1159-81), 280 under Innocent III (1198-1215), 730 under Innocent IV (1243-54), rising to 3,646 a year under John XXII (1316-24)... (Southern, 1970:108-109)

The order of society was in the process of being re-organised as government administrators first reorganized themselves into a seemingly ever-increasing bureaucracy, while wealth and income assessments were done in monetary values, and taxes collected in the king's or sultan's coin. It was the Church's bureaucracy that was growing the most as the unique overseer of the international economy; however, national governments were also expanding, as Southern observes, "Judged simply by the number of official letters that have been preserved, the royal governments of France, England, and even Germany all show a similar trend (to the Church)" (Southern, 1970:108-109). The wide

acceptance of the nations' coins offered the possibility of long-distance trade, portability, and storage capacity of wealth that could be used for a larger variety of goods and services than people had seen before. Kaye further illustrates the impact of expanding monetization of Western Europe, particularly England and France:

The accelerated use of money had ever-expanding social, economic, and intellectual consequences. As the process of monetization gathered speed, habits of thought and perception initially restricted to those actively engaged in commerce came to be adopted by members of all segments of society. Among the most characteristic of these new habits were: the focus on monetary profit and loss in a wide range of decision making; the recognition of the importance of detailed written records for this calculation; the resulting broad development of literacy and numeracy; and the translation of qualitative values into quantitative, often monetary, terms as a way to simplify the process of calculation. The gradual spread of these habits had important historical consequences, especially when they were adopted by administrators of the incipient royal and papal bureaucracies. Administrators discovered that they could greatly simplify the process of assessing and collecting the dues their institutions required by replacing older, less quantifiable determinants of wealth and status with the easily gradable, numerable, and standardized determinant of monetary income from landed and moveable property (Kaye, 1998:285).

As coin transactions became more common for more people, a merchant class emerged from the peasantry. This class became more influential and powerful through the decades, as it was an inspirational class that grew out from the masses. As Ibn Battuta observed of the Mamluk merchant class, "Some of the merchants are immensely rich, so rich that sometimes a single merchant is sole owner of a large ship with all it contains, and this is a subject of ostentation and rivalry amongst them" (Battuta, 1929:22). These traders also knew the experience of the peasantry, knew what they produce, or could produce, and knew what they needed or could use.

The monetization of thought as a means of measurement of natural resources, work, goods and services, was certainly a dramatic change from subsistence and the occasional barter within the peasantry. The dependency on coin led to new possibilities and was creating a fissure in the ridged class system. Therefore, the thought of a new, improved reality had a huge audience in the peasantry and

agricultural labour classes to buy into it in the spirit of hopefulness. Below, a thirteenth century tale of a man's observations at the Pout du Change (the official currency exchange point in Paris) illustrates this popular realization of the power of money:

Why shouldn't silver be well thought of? After all, with it one buys ermine clothes, abbacies and church benefices, cities and castles, great lands and pretty women. It is silver that disinherits the orphan, absolves the excommunicate, renders justice to the scoundrel, and pardons injuries more effectively than pretty words . . . It turns a peasant into a gentleman, makes a happy man of a melancholic, a wise man out of a fool . . . It is silver that ends wars, leads armies, makes ignoble families illustrious. In short, it commands the whole world. (Kaye 1998:17)⁴⁴

As the tale indicates, people's own value was increasingly tied to their wealth, which was tied to trading with cash. However, there was also widespread perception of money's negative effect on society. Kaye (1998) explained this dualistic nature of the medieval perception of money as "both a remarkably successful instrument of economic order, balance, and gradation, and at the same time as the great corrosive solvent, the overturner, the perverter of balance and order" (Kaye, 1998:18). Thus, the incentives for people to get on board to the monetary economy were certainly there, even though there was a corrupting element to it. This 'corrosive' part of the coin economy would have been a welcome problem for those struggling to get by. Therefore, the monetization of England and France came to pass in about a century.

⁴⁴ Legrand 1829: III, 216, extract of "De dom argent":

'car enfin, `a quoi dom Argent n'est-il pas bon? C'est avec lui qu'on achete pe `lic , ons et manteaux d'hermine, abbayes et benefices, cite ´s et cha ^teaux, les grandes terres et les jolies femmes. C'est lui qui fait de ´she ´riter un orphelin, absoudre un excommuni ´ , rendre justice a ` un villain, et pardonner les injures plus efficacement que de beaux sermons . . . Argent fait d'un villain un homme courtois, d'un me ´lancolique un homme gai, d'un sot un homme d'esprit. Enfin il termine les guerres, conduit les arme ´es, illustre les familles ignobles . . . et commande a ` toute la terre." The subject of medieval monetary satire is treated brilliantly in Yunck 1963: 71-108.

Coinage in Islamic lands has a much more continuous history than had been the case in Europe,⁴⁵ and as the case with mathematics, science, medicine, and philosophy, it was the probably through the contact of the Crusaders had with Arab people that resulted in there being an educational enlightenment of sorts. The Europeans lost a lot of knowledge and the Arabs and Islamic people added much more to it and this knowledge transformed the Church and Europe. However, this knowledge was also largely centralised within the Church and it was packaging this knowledge in what it deemed as acceptable and/or self-benefiting ways. This way the Church became the ideological power and the centre of education, law, theology, philosophy, as well as the economic centre of Europe. The Islamic world was not so centralised and no institution had so much power or control over its people, rather it was under the Ayyubid Dynasty and the Mamluk Empire that greater centralisation and administrative bureaucracies were growing. The Islamic unity that was had during the end of the Roman and Byzantine Empires was diminished, and clan connections became more important as fractions and instability developed. Thus, as the Ayyubid and the Mamluk Dynasties became more unified and militarily stronger, so to was the presence of their coinage more widespread. Jones *et al.* illustrate these changes based from an archaeological site of a copper mine in Faynan, Jordan that was open c.1200-1400A.D.,

...the survey pottery assemblage is atypical for rural sites of the period, but it is also important to keep in mind that KNA [Khirbat Nuqayb al-Asaymir copper mine] is not a typical rural site; it was set up to produce a rather valuable and somewhat scarce commodity. As such, centralized organization and elite supervision are suggested, not only by the pottery assemblage but by the nature and function of the site itself.

Moving to the Faynan copper industry in general, recent syntheses of the archaeology of Faynan... do not adequately explain the underlying reasons for the reemergence of copper production in the 13th century. It seems likely that this revival was actually spurred by the sugar industry's demands for copper, which were high enough to make a reliable, local source desirable, especially if

⁴⁵The Maskukat Collection of Islamic Coins <http://islamiccoins.ancients.info/introduction.htm>

papal embargoes on European trade with Egypt and the Levant were being enforced—or even if it was simply feared that they would be enforced (Jones, Levy, and Najjar, 2012:95-96).

This site exemplifies the needs of Ayyubid dynasty and the Mamluk Empire to augment their wealth by increasing trade through a cash economy. The interconnection between the European and Egyptian/Levant economies is illustrated here, as Jones points out the threat the Pope's embargoes of European trade may have had, leading to greater measures taken by the Ayyubid and Mamluk governments, as expansion of its sugar industry and this copper mine. Accordingly, Levant and European governments and the Church bureaucracies became larger and more complex as their responsibilities increased.

6.6 The Divine Word, Law and the European Institutions for the Standardisation of Thought

The dependence upon a cash-economy led to focusing on agricultural production, rather than how to sustainably extract resources from the ecosystem. This societal change of focus has been called a “revolution in attitudes towards money” (Kaye,1998:285). This was not without resistance though, as Kaye states, “Despite the fervent warnings of moralists, money was becoming the measure of all things” (Kaye,1998:285). Money, wealth generation and moral issues were key issues for some of the religious orders of growing popularity of the time, as Swanson explains:

This commercialization was not universally welcomed, and commercialization alone would have been insufficient background or stimulus for the twelfth century's cultural and intellectual changes. The problems raised by the new economy did not have to be confronted; they could be shunned. Attacks on usurers in many ways ignored economic potentialities and realities; many sought to evade rather than resolve the emerging tensions by a radical rejection of ‘the world.’ This is a particular characteristic of religious movements in the period, ranging from the hermits and early Cistercians of the late eleventh century, through the poverty movement of people like Waldes in the twelfth, to the apostolic poverty of St. Francis and his followers in the early thirteenth (Swanson, 1999:8).

Though substantial resistance occurred, especially in the religious orders, resistance proved futile, even within the orders. The Cistercians, in particular, were transformed into an economic powerhouse of great wealth. The order's discipline, hard work, and commitment to humble material existence were the ideal characteristics to generate a huge surplus of wealth. Economic wealth brought the order broad attention, as it was thought that a Divine connection was the origin of any organization or society that thrived. The Benedictines, who were the dominant influence earlier in the Middle Ages, established some precedents that set people's expectations and context of understand. The Benedictine Rule and organization was thought to provide the guidelines for the path to heaven, if that was not desired, then giving a large donation to the order to basically bribe one's way to eternal life was a solicited option.

...if in a single moment the order
of the master's is uttered and the work
and the disciple's work is completed,
with the speed inspired
by the fear of the Lord.

The two things are swiftly completed together
by those in whose hearts
lies the desire of reaching eternal life.

Thus they take the narrow way,
as the Lord says,

"Narrow is the way that leads to life" (Matt. 7:14),

So they do not live according to their own wills,
nor obeying their own desires and pleasures,

but behaving in accordance with the rule and judgment of another,

they live in monasteries and desire to have an Abbot ruling over them
(Parry and De Waal, 1990:21)

The authority that the Benedictines held was without rival. Swanson explained that their rule and the Benedictine monasteries themselves were “the symbol of stability and immutability in a world of flux” (Southern, 1970:28). It is a key concept that was not of the natural world as everything that is alive changes, whether it is individual life forms or ecological systems. This emphasis on stability and immutability is very different from traditional knowledge systems based within their cultural geography in focusing on adapting to their ever-changing environment. (Berkes *et al.* 2010) illustrate this in observing, “Traditional Ecological Knowledge... (teaches) how to cope with dynamic change in complex systems” (Berkes, Colding and Folke, 2000:1259-1260). Clearly, the esteemed Benedictine monasteries were not focusing on the natural environment, but rather with that which does not change.

The respect for the oral tradition was undermined by unification of thought in what was divinely correct and everything else being heresy, as well as by the Church’s concentration on the physical for the connection with the divine. Whereas the written word has “stability and immutability in a world in flux” (Berkes, Colding and Folke, 2000: 1259-1260). The written word also gave the Church the power to make permanent truths and boundaries, which instilled their power and authority. Goody explains,

The process of canonization...derives from the nature of the written text, which encourages boundary-maintaining religions with an approved corpus of holy works. While in oral societies religious utterances such as myths may appear to the actors to be canonized, the process of transmission is in fact much less constraining. Canonical written texts are copied; oral myths are re-created in repetition...(Goody, 2000:130-131).

The use of written text does not allow the tweaking of the story depending on the context, audience, and the storyteller’s propagative. The unchanging nature of the written word has been used in some religious traditions where the words themselves become sacred (Goody, 2000:119-120).

The sacredness of the scripts of religions of the written tradition allows for a stronger power structure, as the amount of impact that individuals can have on the doctrine is limited, just left to commentaries. The Catholic Church was especially successful at producing a huge hierarchical organization, with the supreme leader, the Pope, having infallible status when it comes to religious matters, and the Church Councils that produced Canon Law along with the Papal Letters. As the study of canon law expanded, so did the understanding of it as a legal tradition, largely assisted through Gratian's *Decretum*. Haskins explains these legal developments in the context of the growth of a 'twelfth-century renaissance':

This growth of legalism had two key manifestations, which are particularly important to traditional ideas of a 'twelfth-century renaissance'. The first is the revival of the study of Roman law, and its consequent influence on other legal systems. The other is the growing importance of canon law, the law of the Church, especially after the appearance of Gratian's *Concordance of Disordant Canons* (otherwise known as *Decretum*) in the 1140s. This became the standard text of canon law, in turn encouraging standardisation of canonistic studies, and allowing the structures in which that law was used to develop as well (Haskins 1927:69).

The power of Canon Law was starting to manifest itself in the late eleventh century, which could be seen in the orchestrating of the First Crusade. Canon law was accepted and spread across Europe, leading to the Holy See becoming the most powerful institution in Europe. (Haskins 1927:74).

6.7 Law, Authority and Education in the Mamluk Empire

The centralisation of authority and law had some significant differences in the Mamluk Empire, as the sultans seemed to have relatively more power over Islamic law than their European counterparts did with the authority of the Church. According to Rapoport, the development of Law in Mamluk Empire started in 1265 with the appointments of four chief qadis, one for each law school (madhhab) and constructing the royal Dār al-ʿAdl He states,

In this period, the jurisdiction of the royal and military courts is largely limited to penal law, areas of the law where the shari'ah's strict evidentiary procedures often failed to secure conviction. Later, from

around 1350, the jurisdiction of military officers, especially the chamberlains, expands significantly to include family law and debts... Despite initial objection from religious scholars to these infringements on the jurisdiction of the shari'ah, the expansion of the military-executive courts gathers pace over the course of the fifteenth century (Rapoport, 2012:76).

The power of the sultans is quite pronounced here as religious scholars were able to be ignored in order to expand the jurisdiction of military-executive courts. This may have been more possible for the Mamluk sultanate as major Islamic legal reforms were initiated by Baybars, who appointed, as Rapoport explains:

...four chief qadis in Cairo, one from each of the Sunni schools of law, thereby adding Hanafi, Maliki, and Hanbali judges to the incumbent Shafi'i. The judiciary of Damascus was similarly reformed the following year. Over the next century non-Shafi'i chief qadis were appointed in other Mamluk towns and cities, including Aleppo, Tripoli, Hama, Safed, Jerusalem, and Gaza. (Rapoport, 2012:76)

Rapoport noted that this judicial arrangement was exploited by the sultans or other military-executive officials in that they "exploited the differences between the doctrines of different *madhhabs*." (Rapoport, 2012: 79) They were also directly intervene in criminal and *maẓālim* sessions. Rapoport continues,

With regard to criminal law, some military officials, such as governors or police chiefs, had jurisdiction over criminal cases, such as theft and highway robbery, and they were competent to enforce the Quranic punishments for these offences (*ḥudūd*) or lesser punishments. This was a direct result of strict evidentiary requirements of the shari'ah judges, who required, for example, four eye-witnesses in cases of adultery (Rapoport, 2012:79).

Unlike the Canons and Papal decrees of the Church, Islamic law went into more personal matters that the Church let the secular governments, by-in-large, have jurisdiction over. It can be said, in effect, the same is happening with Islamic Law and the Mamluk Empire, however, the *maẓālim* courts, which seemingly were mainly concerned with, "usurpation of property, abuse of endowments by government officials, and disputes over *iqṭā'* (fief) allocation to soldiers. The

royal maẓālīm sessions also heard cases of blasphemy, apparently because the death penalty (at least for this offence) required the consent of the sultan and all the chief qadis.” (Rapoport, 2012:80).

What is especially noteworthy here is that the sultan had to be consulted regarding cases of blasphemy, which is certainly distinct from the Church hearing such cases. Thus, the centralised authority in Mamluk territories leaned towards the secular authority more than would be seen in Europe. Ibn Taymīyah (d. 1326) illustrates this secular power in his travel diary,

According to the practice (‘urf) in our time, in the regions of Egypt and Syria it is the military authority that carries out the prescribed punishments for criminal offences (ḥudūd) which involve mutilation, such as the amputation of the thief’s hand or the punishment of the highway robber and similar things. It may also happen that the military authority imposes a punishment that does not involve mutilation, such as, for example, the flogging of a thief. It is competent also in litigations (mukhaṣamāt), commercial contracts (?) (muḍarabāt), and “trials of suspicion” (da‘āwī al-tuham) in which there are neither written documents (kitāb) nor witnesses. The office of the qadi is competent in these matters if there are written documents and witnesses (Rapoport, 2012:80-81).

The power of the sultan being interwoven with the power of religious institutions in both the Mamluk empire and Europe are quite similar. The sultan and the king had the authority to put forth brutal punishments outside of religious institutions typically without any interference from either faith organisation. However, these religious institutions had educated the administrative officials that worked inside the secular administration. Gilbert explains about typical career paths of the prominent scholars of Damascus,

A few of the most prominent teachers did not hold jobs in institutions but received the patronage of a king, a wazir, or an amir. Others combined both institutional and personal patronage. Hence regularized salary provisions emerged alongside continuing practices whereby an individual patron directly subsidized a scholar. Patrons, in addition to employing individuals directly, now endowed permanent institutions that sustained groups of scholars. (Gilbert,1980:118)

Gilbert refers to this class of scholars of twelfth and thirteenth century as marking “a turning point in the evolution of Muslim society and community life” (Gilbert,1980:134). Just as the Church in Europe was educating the society through a class of leaders and bureaucrats, the same phenomenon was taking place in the Ayyubid and Mamluk dynasties. Gilbert explains, “the primary function of the madrasa system, in conjunction with other religious institutions of the day, was to create a professional class of scholars that would influence all of Muslim society” (Gilbert,1980:121). These *madrasas* were institutions principally of theology and law, whose influence filtered down through the society. Even though there were four schools of Islamic thought, they all required the same skills to gain respect as a scholar within each respective school.

6.8 Plague in the Mamluk Empire

Islam, unlike the Church, did not see the Plague as being sent by God, and thus, more progress was made in medicine and diagnosing causes of disease. Modern DNA studies and genome maps of *Y.pestis* has shown that the same strain of the mid-fourteenth century pathogen is present today in places like East Africa, making studies of these recent outbreaks very relevant in analysing what happened during Black Death (Bos et al., 2011:506-511, Cui et al., 2014:177, Drancourt and Raoult, 2016, Ruhaak, *et al.* forthcoming). Modern Plague epidemics are associated with rural agriculture, not urban areas (Neerinchkx et al., 2010:102, Ruhaak, *et al.* forthcoming, Spyrou *et al.*, 2016:875-878), which is also seen in the Arabic record. As the observation of Egyptian architect, Hassan Fathy noted, that the consequences of most of the villages in upper Egypt being built upon mounds above the flood level resulted in “their own problems, one of which is that, as the waters rise, all the vermin of the fields—rats, mice, snakes, and insects take refuge in the village, bringing a variety of diseases with them” (Dols, 1977:179). The historical documentation support this assertion as Dols paraphrases Baybars al-Mansūrī, Ibn Abī al-Fadā’il’s, Ibn Taghrī Birdī and others account of the boom of rats that would occur around harvest time,

...From the Mamlūk Period there are ample accounts of devastation which occurred in 696/1297 as a result of rats, whose number increased greatly in Egypt just before the time of harvest. According to the contemporary historian Baybars al-Mansūrī and others, packs of these rats had a race with *fellahin* in the fields, and the peasants were able to save only a small portion of their crops. Ibn Abī al-Fadā'il states that rats during that infestation destroyed the crops of about fifty *faddāns* in the course of one night in one village... there was a similar occurrence in 715/1315 when rats attacked the fields in Upper Egypt. Some officials in the village of Umm al-Qusūr in the Manfalūtiyya province killed a multitude of rats. According to Ibn Taghrī Birdī when these officials wanted to estimate the number of these dead rats, they used a grain measure. They found that in seven days they had killed the volume of 326 $\frac{2}{3}$ *irdabbs*. A report was written by them to be sent to Sultan al-Nāṣir Muhammad in Cairo. Al-Maqrīzī, who puts the figure at the amount of 316 $\frac{2}{3}$ *irrabbs*, states that when these officials tried to count the number of dead rats in a single *irdabb*, they found 8,400 rats in the *irdabb* and 1,400 rats in each *wayba* (one-sixth of an *irdabb*). The province of Manfalūt suffered another invasion of rats in 738/1337-8 which destroyed the crops in the fields and that stored in the granaries. Within one night a quarter of a whole granary was destroyed by rats. Two groups of *fellahin* in turn spent all night, with torches, and all day killing them. There were about sixty thousand *irdabbs* of beans lost for Sultan al-Nāṣir ibn Qalāwū in Manfalūt alone as a result of the rat incursion of that year. Damage to crops by rats is continuously mentioned in sources for later periods...(Dols, 1977:158)

Dols captures accounts of a systematic problem here that increased the conditions that favoured a boom of the rat population to take place in and around agricultural fields in Egypt. When Black Death occurred in the mid-fourteenth century, according to contemporary accounts of Ibn Iyās and as-Sulūk, many animals were devastated as agricultural beasts of burden as cattle/oxen that would have had a dramatic impact on cultivation and the peasantry (Dols, 1977:156, 159-160) as-Sulūk observed that depopulation was especially severe in Upper Egypt, as region of Asyūt where the Mamluk's used to collect taxes from around 6,000 people, but during Black Death only collected from 116 (Dols 1977:161,784-786). Contemporary Rabī' II in 749/June 1348 also observed, as Dol paraphrased that,

The people living in tents around Bilbais perished with their flocks and dogs, and the waterwheels in the countryside were stilled. The markets of Bilbais were deserted, for few would stay in the city. No muezzin was left to call the people to prayer, and a number of the inhabitants emigrated to Cairo. The population of this province (Sharqīyah) was

unable to harvest their crops because of the high mortality rate among the peasantry and their flight from the land where plague had struck at the beginning of the summer (Dols, 1977:160, 784-786).

Agricultural areas where people lived in close proximity to their domesticated animals seemed to have been especially at risk whereas regions that were less engaged in these realms have been documented to large escape the epidemic. As-Sulūk observed that areas that were known for trade and not known for agriculture, as Aswān, were minimally effected, only having 11 deaths, and Syrian towns of Ma'arrat an-Nu'mān, Shayzar, and al-Hārim also largely escaped the epidemic (Dols, 1977:161).

Ibn Taghrī Birdī illustrated the breakdown of the socio-economic systems in the Mamluk Empire by describing how the Sultan al-Malik az-Zāhir ordered the gates around Cairo to be fortified as well as many trenches and moats dug around the Cairo and how the sultan dividing up his positions to build up his military defense, while crying. Ibn Taghrī Birdī also noted that the streets were filled with helmets, coats of mail, swords, and spears were “in demand at any price however high.” Meanwhile, he observed, “the plague was raging in Egypt, with large numbers succumbing daily” (Ibn Taghrī Birdī, 1954:3). It seems very unlikely that the Plague was “raging” in Cairo while Sultan al-Malik az-Zāhir barricaded himself among his people there. This may have been an attempt to keep the Plague out of Cairo in addition to being a defensive military tactic. It is certain that the Sultan was attempting to deal with precarious circumstances while Syrian cities were being taken over by Emir Yalbughâ an-Nâşirî as the Sultan’s opposition grew, Ibn Taghrī Birdī explains:

...Emir Yalbughâ an-Nâşirî, viceroy of Aleppo, his ally Minţâsh, viceroy of Malaṭ, and their adherents: When an-Nâşiri had established himself in Damascus and had taken possession of the city after the battle there, he proclaimed in all the cities and citadels of Syria that all viceroys, emirs, and soldiers should appear promptly in Damascus, and that, with the exception of those assigned to guard the cities, anyone who delayed should forfeit his fief and be deprived of his possessions. Men gathered in Damascus from the entire country, and an- Nâşiri, having distributed money among them, assembled equipment and made other preparations for departure from Damascus....he went out from the city with the vast

number of his soldiers, emirs, Kurds, Turcomans, and Arabs who had rallied to him (Ibn Taghrī Birdī, 1954:3).

The augmentation of Emir Yalbughâ an-Nâsirî's power likely depended upon the backing of rural lands, as cities, though likely grew some of their own food (Quickel 2016), depended upon surpluses for their development of wealth. Yalbughâ an-Nâsirî went on to a successful invasion of Cairo, in part due to his alliance with the Bedouins. Ibn Taghrī Birdī recounts the formation of these alliances,

Reports ...came one after the other to the Sultan that all the Syrian emirs, as well as the Ashrafi and Yalbughâwî mamlûks, had acknowledged the sovereignty of an-Nâsirî; that Emir Sûlî Ibn Dulghâdir, emir of the Turcomans, and Nu'air, emir of the Bedouin Arabs, as well as others of the Turcomans and Bedouin, similarly had promised obedience to him in making war upon Sultan al-Malik az-Zâhir (Ibn Taghrī Birdī, 1954:26).

This increased resistance to Sultan al-Malik az-Zâhir depended upon the alliances of the opposition. Therefore, the Bedouins were often courted to establish alliances, as they were largely dominant in rural Egypt and the Levant. The peasantry and agricultural cash-cropping system was in disarray and the presence of herding increased, which also was advantageous for raiding, gave greater flexibility in movement and greater adaptability to extract food and cash to support themselves. The flexibility and adaptability of the Bedouin during this unstable period was key to their territorial expansion and influence.

6.9 Herding and Farming dynamics in the quest for the vital resource of fertile lands

It is interesting that both the Gaels and the Bedouin are often defined in the historic records as herding raiders that were almost continually involved in war, when certainly this was a small minority of the population (though this population seemed to have grown substantially during time of instability). It should also be remembered that even if the Gaelic and Bedouin raiders were small in number the impact they had on settlements was high. Settlements would have been difficult to defend as they are large areas that can be attacked at any time. Agriculture is also a very labour intensive activity and in times as

the late thirteenth and fourteenth century when the yields were going down substantially and they were having a difficult time surviving, being raided would have been especially devastating. Thus, the impact of the raids has been especially disproportionately recorded in the historic record as these raids threatened an already teetering system from continuing. The strength of a sultan, king, or the Pope ultimately depended upon surplus agricultural production in the fields for their accumulation of wealth to be able to increase their power through expanding their bureaucracies and institutions, as well as their military might. Thus, the historic record highlighted the Gaelic and Bedouin threat and tended to portray them in a very unfavourable light. However, this does not explain the reasons for “Bedouinisation” and “Gaelicisation”.

If settlers were having a difficult time surviving, who were they going to learn from to increase their chances of survival? Taxes were increasing while in the 13th century there was an oversupply of commodities in demand, leading to greater intensity of cultivation and the expansion of agriculture onto marginal lands. However, eventually the fertility of these fields started diminishing, and in the case of Egypt the dams that regulated the flooding fell into disrepair. Thus, agricultural yields were decreasing and another way of life to survive would have been in demand. Herding animals can eat vegetation that humans cannot, which diminishes the impact of the lack of agricultural production, and there is much more flexibility in movement to keep a herd fed. Borsch illustrates this phenomenon with the Bedouin sheep and goat herders taking advantage of the situation in rural Egypt,

...a broad spectrum of weedy plants known as *khirs* were the by-product of an irrigation system that had fallen into utter ruin. As parts of the irrigation system fell apart, the Nile floods washed in and out of basins, leaving *khirs* as the only species suited to the altered soil and water ecology. For agriculturalists, silted canals, collapsed dikes, and weed-clogged basins were uninhabitable ruins, beyond salvaging by even the hardiest autarchic peasant communities. Yet for the Bedouin, these areas were a perfect ecological niche, a niche where they could feed their sheep and goats and where their power and numbers could blossom. Bedouins not only profited from rural depopulation and the gradual decay of the irrigation system, they also actively participated in it, cutting dikes and

ruining basins to intentionally foster their own expansion (Borsch, 2005:51).

Borsch's example in medieval rural Egypt exemplified by the *Musical Chairs* hypothesis of Angourakis et al. (2014) (see page 60) between herders and agriculturalists. Herding, being more mobile and less predictable than agricultural settlements diminishes their vulnerability to a raids. Additionally, herders can also be raiders of settlement areas and former settlers would have strong instincts as to what parts of the settlements would be most beneficial and vulnerable to target. Thus, the late thirteenth and fourteenth century is characterized by an abandonment of agricultural fields and greater dependency upon herding.

The *Musical Chairs* model is exemplified in the late thirteenth and fourteenth centuries. Livestock and horse populations seemingly increased in much of Afro-Euroasia; trade became more regionalized as the Silk Road no longer was a reliable trade route and trade between Europe and the Mamluk became more unstable, and war between the Mongols and the Mamluks continued until the early fourteenth century, while within Europe, the wars between Scotland and England, and between England and France lasted over a century. Additionally, Angourakis *et al.* notes that "the competition for land use is sensitive to extrinsic growth." This depends upon the "movement of people and resources into the territory" and "the increase of external pressures over the local production [e.g. market demand, political factors, due to a rise of prices]" (Angourakis et al., 2014:422-423). An example of the movement of resources into a territory is seen through the Turkish herders, as Ibn Battuta observed:

The horses in this country are very numerous and the price of them is negligible. A good one costs about a dinar [of Morocco] of our money. The livelihood of the people depends on them, and they are as numerous as sheep in our country, or even more so. A single Turk will possess thousands of horses (Battuta, 1929:31).

The large-scale trade for horses indicate that this region is dominated by herders and the easy access of they have to the surrounding areas will also lead to

greater pressure put upon agriculturalists. This is seen with both the Bedouin and the Gaels as they had very substantial amount of territory to access for herding, which allowed them to continue in farming areas. This is an important point as without these lands in relatively close proximity the farmers may have dominated. However, the Gaels and the Bedouins participated in both farming and herding, which gave them an unusual amount of flexibility. This was especially true since they were the most established, or especially in Ireland, probably the only herding people.

Herding may have indeed given the Gaels and Bedouin a degree of adaptability that other people did not have. When the cultivated fields became less fertile there is a limited amount that a farmer would be able to do, especially one tied to cash-cropping (which limits the flexibility of the crops that are profitable to grow). Herding allows more flexibility and the ability to adjust to observations of environmental changes that farming, especially cash-crop farming, does not. Additionally, once land use starts to switch to herding there are factors to continue this trend, Angourakis *et al.* (2014:422-424) Explain:

A progressive increase of herding integration in relation to that of farming can rapidly turn the tide of land use patterns, transforming a big oasis [for farming] into a small one [for herding]. Since integration is the connectivity among people and resources involved in the land units of the same class, it can be interpreted as a proxy of territorial identity and political cohesiveness, highlighting the importance for pastoral societies of investing in kinship and group identity reinforcement... Moreover, we can postulate that the emergence of strong pastoral identities is the result of the pressure of farming on key point of transhumance, such as oases.

The links to other people are needed in a way that are not so continually necessary for agricultural settlers. Mobility and pastoralism are tied together as the herders find a way to access grazing lands and water that their livestock needs throughout the year. These needs of the livestock must be provided in locations that are feasible for their animals to migrate, as their lives depend upon it. This takes a lot of organisation and knowledge of the landscape, as different herders must not be occupy the same grazing lands, or the area will become

overgrazed. Therefore, as Franz noted below, pastoralists have had a tradition of keep the following resources in mind in order to keep their herds healthy:

1. livestock
2. pasture
3. water places
4. commodities
5. rights of way
6. labour
7. cultural faculties and repute (Franz, 2005:57).

As Angourakis *et al.* illustrated with their *Musical Chairs* model for grazing lands, access to suitable grasslands for herds is ever changing as the dynamics for agricultural settlement and grazing lands change. This state of *Musical Chairs* of desired territory creates a great amount of uncertainty and demands strong social networks that can be quickly accessed for any threat that may come to the herds of the people that depend upon the commodities that the animals provide or give access to as they provide the transportation for trade. As settlements were more frequently being abandoned from the late thirteenth century, the Gaels and Bedouin were increasingly feared in the fourteenth century before Black Death struck as their networks became stronger and their raids increasingly feared. Their success in addressing their needed resources for herding would have been key to accomplish their expansion.

6.10 The Obscure Bedouin: Building Alliances, Kinship and Resilience

The flight of the peasantry from their agricultural lands during the fourteenth century was in response to poor yields, Bedouin raids, and diseases including the Plague. Thus, many fled to the cities where they had stored grain surpluses stored, military protection, and the perception of less disease. However, as illustrated earlier with Sultan al-Malik az-Zâhir barricading Cairo, some cities

may not have welcomed the influx of people from the countryside, not only due to the Plague, but the threat of attack from opposition forces, including the Bedouin or peasants who were Bedouin sympathisers. Since the cities had a finite amount of resources that were diminishing due to the lack of rural agricultural production, there was a limited amount of people that the cities could be absorbed. The lack of Mamluk protection and assistance for these rural agricultural labourers would have diminished their loyalty to the government, whereas they would have seen the influx of Bedouin presence in the rural lands. The rural settlers were running out of options for their own survival, as if they could not feed themselves with their harvests, protect themselves from Bedouin raids, nor gain much support from the Mamluk government. Thus, joining the Bedouin may have appeared as the best option for many. The rural settlers who joined the Bedouins would have increased their numbers for military conflicts and raids, which potentially would have made them into a greater force to reckon with. Though the Bedouin were quick to make and break alliances for their own benefit, these alliances seemed to have been stronger than that made with centralised governments as the former settlers were in a similar position as the Bedouin and had much to gain from learning how to survive without permanent settlements (Leder, 2015:114, Borsch, 2005:51).

6.11 Identity of the Bedouins in continual flux

The answer of *who are the Bedouins?* seems to depend upon the time, place, and who was answering the question. First, it must be said that this is a term that those labelled as Bedouin would not use to describe themselves. They would identify with tribal bloodlines and geographic area. However, outsiders labeled these people that had socio-economic and cultural differences with the mainstream population groups. The Bedouins would have been labeled with the most distinctive characteristics that these outsiders identified, which would have been the mobility/nomadic qualities that stuck out the most. Though the nomads are often seen as the purest form of Bedouin (*badw*) civilization, they have to be seen forming a large economic spectrum from permanent settler on

the one end and pastoral nomads on the other. As Rapoport explains the camel herding nomads only are “a sub-category within the larger group of *badw*, a group that includes peasants and nomads, cultivators and herdsmen” (Rapoport, 2004:3-4.). Walker notes that “Among the ‘*ushrān* of Jordan, Syrian sources differentiate between the *urbān* and *ahl al-balad*. The *urbān* (s. ‘*arab*) appear with the most frequency on account of their attacks on state officials and villages and raids on trade and pilgrimage caravans.” Rapoport noted that *urbān* is “a non-classical plural form of ‘*arab*”, which refers to “all those descended from Arabs, whatever their way of life may be.” (Rapoport, 2004:3). However, Walker (2014:119) explains the *urbān* “were not Christians, local merchants, or town dwellers.” There does not seem to be much consistency in the historic record regarding who is labelled as a Bedouin and who is not as well as what it means to be a Bedouin. This lack of a clear definition of who they were highlights the flexibility and adaptability of the population and at least from the outside view, who may be included as being Bedouin and who is not. Thus, any points regarding the Bedouin must be accepted with a certain margin of error. However, the context that Bedouin accounts were written in could explain much of these disparities as different agendas were being put forth that the Bedouins were used to bolster. Earlier accounts were often more favourable to the Bedouin, as Leder illustrates:

While literature and history, particularly in the Umayyad period, very often present the Bedouin in a positive light, as a model and example of virtue, the difference between Bedouin and settled people is much in evidence in religious law and politics. In these areas, contempt is frequently shown for the Bedouin and ... is a politically significant message indicating the struggle for power (Leder, 2015:113).

The Bedouins would have been especially problematic for governments that depended upon cash-crop agriculture, as they would have been difficult for such governments to tax and applying and enforcing laws (Leder 2015:113). The means of assessing and recording assets, as the Rawk (1313-1325A.D.) would be extremely difficult to do with pastoralists and even laws that promote agriculture would have been difficult to enforce in rural areas as there typically would not be the military personal to be able to financially support such

ventures. Scholar al-Subkī (d. 771/1331) complains of this impact the Bedouins had been having on fertile, rentable land, which has been a headache for the Sultan,

Concerning the current Bedouin emirs: These (Bedouin, *al-'arab*) are those who (periodically) roam and make camp. God has granted them (their emirs) a rich living and huge rentable land, so that they would not afflict the Muslims with their devastation. Alongside their mischief is now the fact that, as soon as the sultan seizes a tract of rentable land from one of them, he then sets about making the ways unsafe and harming those who have committed no wrong. In doing all this, he does not shrink from spilling blood (Leder, 2015:114)

It may be most accurate to define the Bedouin as a flexible and adaptable people that can be agriculturalists, pastoralists, settlers, semi-nomadic, and a very small population sometimes may even be considered nomadic. The Bedouins are often thought to be avid traders, which may not depend upon alliances or way of life. For instance, the Bedouin population of Mamluk territories would align themselves sometimes with the Mamluk Sultan and other times with the Mongol's, but they would trade with nearby settlers and be a conduit for long distance trade. As Ibn Battuta in his travels from Medina to Mecca illustrated:

Three days after leaving Rabigh we reached the pool of Khulays which lies in a plain and has many palm-gardens. The Bedouin of that neighborhood hold a market there, to which they bring sheep, fruits, and condiments. Thence we travelled through 'Usfan to the Bottom of Marr, a fertile valley with numerous palms and a spring supplying a stream from which the district is irrigated. From this valley fruit and vegetables are transported to Mecca (Hallsall, 2011:74-77).

The trading of sheep and fruits indicate a link to herding and farming. This does not mean that there were Bedouin herders and farmers at the market, however that could be the case. Maybe more likely would be that the herders traded with farmers, but were those farmers Bedouin or did they just have a trading relationship with farmers? It is difficult to say. However, it should also be said that Bedouin clans have not had the reputation of necessarily being in alliances with other Bedouin clans, as Palgrave observes,

Their feuds are continual, but at little cost of life; the main object of a raid not slaughter; and the Bedouin, though a terrible braggart, has at heart little for killing or being killed . . . His only object in War is the temporary occupation some bit of miserable pasture-land or the use of a brackish well; perhaps to get such a one's horse or camel into his possession-all objects which imply animosity...(Palgrave, 1865:23).

This is a nineteenth century account, but still illustrates the flexible alliance culture that has been an essential ingredient of the Bedouin way of life. This also exemplifies the importance of blood-lines for kinship, as these were not flexible and adaptable and thus, clan membership remained relatively constant and would be the backbone that any decisions of alliances were drawn from. The Bedouin were more conservative with their kinship than other Arab people, who were more similar to the Gaels in drawing their relationships from a broader range of connections, including milk kinship (Parkes, 2004:587-615; Parkes, 2003:769).

6.12 The Northern Gaelic Cultural Area, Carrying Capacity of Grazing lands, Kinship and Resilience

The Gaelic circumstance in thirteenth and fourteenth century Ireland was distinct from the Bedouin in terms that their lands were influenced by two centralised powers, the Roman Church and the secular power, the English kingdom. Whereas, the Crusaders were being driven from Levant, the colonisation of Ireland was increasing in intensity. The increased presence in the twelfth and thirteenth century of the socio-economic system supported by the Roman Church and other secular powers took its toll on the Gaelic Irish Church, which was marginalised. Thus, the trading economy took hold in many ecclesiastic centres where it was not already rooted. Nevertheless, the trade-based economy was present centuries before the English Invasion in larger ecclesiastical centres including Clonmacnoise and Armagh that had a long history of Continental connections. The trade-based economies present at these established churches as well as the early twelfth century establishment of the ecclesiastic manorial system, reshaped much of the Irish terrain, as Downham explains:

...Economic development inland. Armagh, Downpatrick, Kells (Meath), Kildare, Cashel, and Clonmacnoise functioned as ecclesiastical and regional centres. The trend in the tenth and eleventh centuries had been towards clustered settlement patterns. In the eleventh and twelfth centuries overkings invested patronage in political and ecclesiastical centres and constructed routeways and bridges to control movement across the landscape...Control of landscape was achieved through centres of lordship but also spatial organisation into units for taxation, local government and military levies. Before the English invasion this had been achieved through a unit termed *trícha cé*t (*thirty hundreds*), of which around 185 have been identified island-wide. These units were used later by the English who renamed them cantreds. *Baile* (*biataig*) were smaller units, an estate usually belonging to a kin-group which often coincided with later parish and manorial divisions. A new diocesan framework was worked out in the early twelfth century, culminating in the Synod of Kells in 1152 which organised Ireland into 38 diocese although it would take some time before parochial organisation was in place. At the eve of the English invasion Ireland had a system of territorial divisions similar to its European counterparts, although power was less centralised than in the neighbouring kingdom of England (Downham, 2017: 184-85).

The establishment of the trade-based economy was well established in many monastic bases through much of Ireland. Its secular development in the eleventh and twelfth century was especially well established in Connacht with the construction of castles, and a causeway and bridge on the River Shannon at Athlone in the eleventh century (Downham, 2017: 185). However, much of Ulster did not follow suit. Unlike much of Ireland, Ulster had much less deforestation, and had substantial re-generation of the forest in the Northeast in the late thirteenth and much of the fourteenth century (see The Bruce Invasion of Ireland 1315-1318 Map in ch.5).

The relationship Gaels had with their environment is reflected in the Gaelic laws that protected many tree types (See Kelly 1999) from being unsustainably exploited. This traditional belief in the interconnection and interdependency of the Gaels with nature is seen in parts of *Acallam na Senorach* (c.1200A.D.). The excerpt of this story reflects on the Fíán's (a band of warriors') traditional livelihood and economy through the evidence of what sustained the people in the past in a positive light. This is seen after Patrick (patron saint of Ireland) asks Cailte where the best hunting that the Fíán ever experienced had taken place. Cailte (one of the last surviving warriors led by Finn mac Cumail) goes back into

the past to tell a story that shows the way of life of the Fíán when traditional beliefs and spirituality were interwoven with nature. Caílte explains,

In the month of *Trogan*, or *Lugnasad*, (1 August) we of the *Fíán* used to go there (Arran) with three battalions and have our fill of hunting until the cuckoo called from the treetops of Ireland. No music can match the sweet sounds of the bird flocks rising up from the waves, and from the shores of the island. There were one hundred and fifty flocks around it, all of bright colours, deep and clear blues, greens and yellows.’ Caílte then recited the following verse:

‘Arran blessed with stags, encircled by the sea,
Island that fed hosts, where black spears turn crimson.

‘Carefree deer on its peaks, branches of tender berries,
Streams of icy water, dark oaks decked with mast.

‘Rocks with purple lichen, meadows rich with grass,
A fine fortress of crags, the leaping of fawns and trout.

‘Gentle meadows and plump swine, gardens pleasant beyond belief,
Nuts on the boughs of hazel, and longships sailing by.

‘Lovely in fair weather, trout beneath its banks,
Gulls scream from the cliffs, Arran ever lovely.’ (Dooley, Harry, 1999).

Note the poetic description of different entities of nature, while at the same time this area feeds the stomachs of the Fíán. There seems to be a tremendous amount of symbolism here, which seems to indicate the author’s view that a spiritual force was behind the great environmental health of Arran.

Gaelic traditions of protecting the forest, hospitality, and networking through fosterage and kinship is especially strong in Gaelic poetry, as well as outsider accounts in labeling the Gaels as more “backward”. The European trade-based economy did not have deep roots in areas that remained under Gaelic control, or at least not in the same way. This was the land of many mercenaries, but not many large farms or grazing areas, and less permanent settlements than other regions. One of the strongholds of Gaelic culture in the fourteenth century was northern and western Ulster. The connection with the Irish Sea and the Scottish Highlands and the Gaelic Isles seemingly led to a more cohesive culture than Ulster had with its southern neighbours, especially in eastern Ireland. This land

seemingly was divided on carrying capacity rather than static geographic boundaries. Ross explains the use of the advent of the word *soum* in fifteenth century Scottish documents to describe units of pastureland,

In Scotland, some fifteenth-century documents refer to the stinting of pasture into soums, which can be defined as an imposed unit of pasture that supported a finite number of livestock at different times over the course of a year. At its most basic level, a soum was commonly calculated to be the equivalent of the grass requirements of one cow. This could be converted into other livestock units: for example, a soum could pasture anywhere between four to ten sheep instead of a cow and a horse was frequently reckoned to be the equivalent of two soums. Some sources give both the summer and the winter soums for a particular area and, as might be expected, the summer souming figure was usually greater than the winter soum. However, this was not always the case and occasionally the winter souming figure exceeded the summer total, indicating that some localities in Scotland specialised in foggage (winter pasture).” (Ross 2006: 214)

It seems since livestock, particularly cattle had such a high socio-economic priority, much attention was paid to feed them. Milk and to a lesser extent beef was a vital nutritional resource and the animals could consume much of the vegetation that humans cannot. However, an over-supply of cattle would pose a grave risk. If they ate the vegetation above its replacement rate, then they would more likely suffer from malnutrition, increasing the risk of disease spreading through the herd (Mashishi 1999). Accordingly, the Scots use of *soum* the unit of land would be based upon the season, animals that were grazing there, and seemingly how lush the vegetation was that year. Ross states,

While there seems to be no direct Latin equivalent of the word ‘soum’ in early Scottish sources... When the Scots started to replace to Latin in some documentation towards the end of the fourteenth century, the word ‘soum’ or ‘sowm’ began to appear and almost always in connection with individual farms or townships...All of these grants relate to the church. Similar types of grant to secular parties before c. 1350 are much rarer (Ross 2006:216-217).

Ross notes recording of secular grants may not have been recorded in the main documentation of the time, ecclesiastical records, but in either case it is apparent

that the Church was responsible for aligning the units of lands into parishes based upon production capacity. Ross explains,

It is becoming increasingly clear to historians that the landscape of Scotland was divided up into different units of land at some point in time before parishes were created. These units were variously called dabhaichean, merklands, husbandlands, arochars, and tirunga to name a few...since King David I (1124-1153) is traditionally held to be responsible for the enforced payment of teinds to local churches, which in turn led to the creation of parochial units. (Ross 2006:215)

It is worth consideration that the reason that *soum* appeared in Latin in the late fourteenth century and secular grants started appearing after 1350, may be due to the perception that the traditional Gaelic systems had much more resilience against famine, livestock epidemics, and Black Death than the manorial economies. For this system is not only about the land's carrying capacity for livestock. Nugent explains,

For the Gaelic clans, territory was not just defined socially through kinship ties and obligations, its landscape character was also celebrated and appreciated. The Anglo-Norman and New-English settlers saw territory in a more abstract manner. The former divided the territory into a rigid hierarchy of different sized sub units to which the different strata of society were allotted. Within this society, there was a slot for everyone and everyone knew their slot. The latter saw the different sub units as commercial commodities devoid of any social significance to be filled and emptied, bought and sold as the market dictated. (Nugent, 2007:5)

The sufficient distribution of resources to support a clan's population is somehow similar to making sure the carrying capacity of a piece of land was adequate for the livestock grazing on it. In both cases, they differ dramatically from the secular or ecclesiastic manorial system in dividing lands to maximize production capacity both of the land and the people working it. The accounting practices and taxation put people under greater centralised control, while the knowledge of these people's well-being or the sustainability of the land would have been limited. The centralisation of control had no effective mechanism to give such information, nor did the tight hierarchy have much incentive to flag up such information, especially in a desperate time of war. This was not the case for

the Gaelic clans, however. Strength of leadership was through gaining people's confidence in their leader's ability to spread his resources to all that supported him, rather than taking as much as possible from the people in order to support certain agendas, as was the case for the Church and England, and most of Europe.

The Gaelic support networks were extremely broad, from illegitimate children having inheritance rights (male much more than female), fosterage, milk kinship, gossipred ("a pledge of fraternal association between individuals, often between a lord and client" Downham 2017: 235), as well as along marriage and hereditary lines. These cultural institutions are about alliance building to increase social networks and family security. It was important to both expand these social networks of interdependency as much as possible. Additionally, these networks had to be integrated as intimately as possible emotionally, spiritually, and culturally to these bonds of allegiance. Cattle trade (wealth) would follow, redistributing the wealth, which would increase the health of the members of the network, and therefore benefiting the security of the members of the social network.

Fosterage, milk kinship and gossipred were ideal systems to help bring greater security through interdependency and inter-responsibility. These cultural practices were used by high-ranking families to increase vertical connections with lower classes (Downham 2017: 234-36). Fosterage was also an apprenticeship system where the foster child being raised by a family of lower standing would learn skills. This sometimes involved payment, but most importantly alliances were drawn this interwove interdependency and greatly encouraged the distribution of resources, as not doing so may well result in harming one's own child.

Milk kinship is a type of fosterage that involved wet nursing from a woman that was not the child's birth mother, which would form an alliance between the two families. This practice was common in Arabia and Islamic lands, during the Roman Empire and proclaimed by Aristotle that "natural communities (*koinomia*) (were) being constituted by common milk kinship (*homogalaktes*)" (Parkes, 2004:590-591). These forged alliances were used to establish vertical alliances

as well as to foster peace between warring tribes The Irish tradition seems to be well established. A story of Cú Chulainn as the bond between the god Lug and the alienated sister or daughter of King Conchobar of Ulster illustrates the cultural importance of fosterage and milk kinship. Parkes (2004: 602) retells the tale, Cú Chulainn, named Sétanta at birth, was supposed to be the offspring of a miraculous union between the god Lug and his mother Deichtine, variably represented as an alienated sister or daughter of King Conchobar of Ulster. On his birth, he is immediately given in fosterage to Cet mac Mágach, an exiled vassal of the Irish over-king, who in turn hands him over to his own foster-parents, Srian and Gabur, for nursing. The infant Sétanta thus becomes a milk-brother of their son Lóeg, who is taken from his mother's breast to nourish the hero, and who will afterwards serve as his devoted charioteer.

Sétanta is later taken into childcare by the blacksmith Culann, referred to as his *aite* "foster-father," from whom he is renamed Cú Chulainn, the hound of Culann, after impetuously killing the smith's watchdog. Prior to this, after leaving his parents and infant fosterers, he commends himself as a five-year-old vassal to King Conchobar of Ulster, seating himself upon the king's knee as a sign of his adoptive affiliation (cf. Thurneysen 1930). Conchobar then appoints his sister Finnochóem as the hero's new foster-mother. Other prominent Ulstermen compete for the honour of further fostering the heroic child, who is subsequently raised and trained in martial arts by the amazon druidess Scáthach together with other noble youths, who thereby become his *comaltai* "fosterbrothers-in-arms" (Synopsis from van Hamel 1933:1-8, 39) (Parkes 2004:590-591).

The interconnections made here are notable, from the retying the line to King Conchobar to the foster "apprenticeships" with a blacksmith and a martial arts druidess, as well as the infant fosterage alliances arranged. These links, seemingly divinely inspired through god Lug, "provided him with widespread adoptive linkages throughout Ulster" (Parkes ,2004:599)

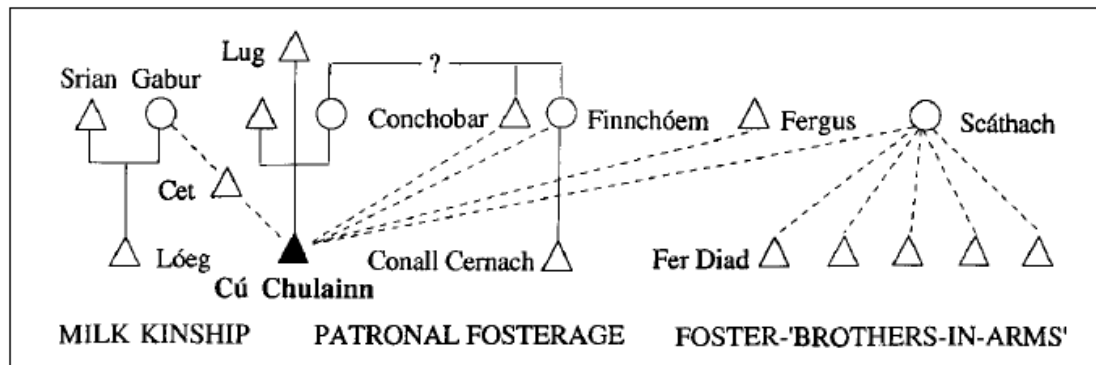


Fig.6.2. Cú Chulainn's foster kin (Parkes 2004:599),

These links obligate Cú Chulainn (Fig. 12) to defend all ranks of society to repay his debt for his fosterage. However, such alliances drawn through fosterage were not unusual, as Parkes explains:

... such plural fosterage was not uncommon in medieval Ireland: it was normal for a child of high status to be appointed a principal fosterer at birth, who would then subcontract the child's nursing and training to sub-fosterers, variously skilled in educational arts (Parkes 2004:599-600).

Fostering was thereby "used by great dynasts, particularly in the form of multiple fosterage, to acquire a political following of lesser nobles" (Ó Córrain 1977:77). For Cú Chulainn, however, these plural fostering relations also play fundamental *moral roles* in juxtaposition with other ties of kinship and contract. (Parkes, 2004:599).

Fosterage stories such as these have been told in Gaelic lands on both sides of the Irish Sea, which helped foster interconnection and alliances in times of war, when individuals were in need of protection, food or housing. These Gaelic traditions of protecting the forest and the interconnectedness of the people through fosterhood, milk kinship, inheritance rights, and the responsibility taken by the clan over individual in Brehon Law led to a more flexible and adaptive society that typically saw their best interest in looking after each other. Power and support of a leader was based upon how well he looked after those he was obliged to protect. It was the people that a leader invested in to gain power, not the ownership of the means of production. (This may contrasted with Anglo-Irish socio-economic systems). The dispersing of cattle to foster alliances would have

diminished the ecological impact of a large herd in one area. The strong social network would have led to more efficient use of food, as well as the belief that helping someone today would have benefits in the future was also something that people would have more faith in the stronger the social network became.

III. Discussion

6.13 Assessing Socio-economic Similarities between the Bedouin and Gaelic & their Development of Resilience to Food Crises and Zoonotic Disease Epidemics

The importance for finding systematic and institutional similarities between the resilient Gaels and Bedouin is to gain understanding regarding characteristics both biological and ecological, as well as the socio-economic systems and institutions that promote these more resilient changes. Table 1 list of inquiries from the Methodologies chapter will be used to review the Bedouin and Gaelic, first regarding the biological and ecological factors (as seen below), and then inquiries focused on the socio-economic systems and institutions. The biological and ecological points of inquiry are as following:

- 1) Based upon the vulnerability factors for a human zoonotic epidemic,⁴⁶ is there evidence of heightened risk at the site?
- 2) Is there evidence of food insecurity & malnutrition/co-infections?⁴⁷
- 3) Is there evidence of deforestation, vegetative clearance, &/or erosion?⁴⁸

The Bedouin and the Gaels traditionally needed to be accurate assessors of their natural environments to feed their herds and sustainably live off their lands. They needed to have economic adaptability and flexibility to deal with the changing landscape, especially as greater military powers with centralised economies transformed the landscape through cash-crop agriculture to quickly

generate wealth. Thus, both the Gaels and Bedouins made livings in a range of activities from being agricultural settlers to semi-nomadic herders, raiders and warriors. Though a minority of both the Gaels and Bedouins were herders involved in raiding, this increased during the late thirteenth and fourteenth century, which led to greater territory in their possession after Black Death. The Gaels and Bedouins engaged in fluid alliances that were based upon short-term benefit, as well as relatively more reliable clan networks. Both groups were difficult to pin down when times became more unstable as many increased their mobility during such periods and were apt at establishing trade networks as well as gaining income through herding and employment as mercenaries. Additionally, both groups were part of relatively small clan/tribal networks that distributed wealth to the needs of its members. These relatively small organisational systems were also able to adapt to observed changes of the environment (i.e. carrying capacity for herding animals) and social realities (i.e. manor or plantation farming, large military threats) quickly and efficiently, which stood in stark contrast to the Church, the English and Mamluk monarchies. Additionally, the basis for their knowledge was less dependent upon the authoritative words of a centralised institution (as the Church, or a secular power) and focused relatively highly upon their own observations of social and ecological change as the basis of the actions that they took.

Begon and McMichael's vulnerability factors for a human zoonotic epidemic were also relatively low for the Bedouins and Gaels outside of the permanent settlement, commodities-based trading economy. Regarding McMichael's factors for a zoonosis, *altered habitat* and *biodiversity change and habitat fragmentation* the impact of the Bedouins and the Gaels was less than their agricultural counterparts in that many were more mobile and less dependent upon the particular ecological services (as wheat production) of a certain geography. Thus, they were not as trapped into an economic situation based on tax revenue and the cash economy than their counterparts in the rural agricultural economy. Therefore, with McMichael's next factor, *Intensified farming and animal husbandry*, the relative mobility allowed them more freedom from the tax burden that the powers they lived under demanded, which often forced the

peasantry to over-exploit the land. Bedouins and the Gaels certainly may have promoted some niche invasion, especially of foreign livestock, which may have indeed had an effect on the environments they were living in. However, this generally would not have had the intensity seen in the permanent settlements where a particular cash-crops, as the sugar plantations in present-day Jordan in the Mamluk Empire, would have dominated a particular landscape year after year, or livestock, as sheep, would have continually dominated the same area. Thus, the impact of the niche invasion fostered by the Gaels and Bedouin would have generally been less, which would have also been the case with *Human-induced climate change*. Micro-, local and regional climate change requires substantial land cover change is not associated with small mobile herding practices, though Gaels and Bedouin on permanent settlements may have indeed contributed to some climatic effect in the immediate vicinity. However, the impact by those not living on permanent settlements would have been greatly reduced as the sized of the territory that they would have affected would have been smaller and if they routinely left the land for some time there would be some re-generation of the land. Accordingly, the impact on the vegetation cover would not be as dramatic as the permanent settlement areas.

Regarding Laudisoit's and Begon's factors for a zoonotic epidemic, as noted in the previous chapter with the Gaels, Laudisoit's *Encroachment on pristine forests, Bushmeat consumption, Trade of forest products and bushmeat and the illegal or uncontrolled nature of the trade* may have all been risk factors with the Bedouin as well. Encroachment into forests represent opportunities to exploit different ecosystem services that otherwise may not have been available, which includes both plant-based and animal based resources. These resources may have been available for trade or consumption. During times of instability and ecological crisis these resources would have been especially valuable, but there also would be some risk of contracting a zoonotic disease, especially in the consumption of wild game. Additionally, Begon's risk factors: *Increase presence of emerging infectious disease in wildlife* and *The increased interaction of area wildlife with humans* are also certainly possible with the Gaels and the Bedouins, while it is difficult to say if there would have been more disease within the wildlife

community, as land became more scarce they may have come in contact with more wildlife. The key here may be mobility. Unlike the permanent settlement areas where peasants slept under the same roof with their livestock (was common in medieval Europe), the mobile Gaels and Bedouins would have been more difficult for pathogens to adapt due to herders lower population density and not staying in an enclosed structure with their animals. Additionally, the Bedouin and Gaelic diet would have been more diverse with a higher protein intake, which is essential for strong immune system functioning (Randolph *et al.*, 2007:2788-2800).

What socio-economic systems and institutions led to the greater resilience of the more mobile Gaels and Bedouin will be reviewed through the Table 1 inquiries. These points of inquiries are as follows:

- 4) Has there been an increasing emphasis on language built for trade over ecological observation?⁴⁹
- 5) Is there evidence of trade/economic change leading to educational/enculturation change in society?⁵⁰
- 6) Is there evidence of growth in Social organisational size & complexity, which diminished the society's problem solving efficiency?⁵¹
- 7) Is there evidence of societal instigation of an ecological crisis through unsustainable socio-economic systems and institutions?⁵²

Tainter's (1990:118) *four concepts that lead to understanding collapse* notes that "Human societies are problem-solving organisations" and "Sociopolitical systems require energy for their maintenance." The Bedouin and Gaelic had relatively small and less complicated organisational structures (compared to the Mamluk, English and Church bureaucracies), which required less energy to function, while being able to deal with problems more efficiently. Using Mann's five stage

process of social organisation, it appears both the Gaels and the Bedouin would fall into Mann's relative or absolute rank societies, what he considers the second stage of organization where he states:

(they) are not egalitarian...(and) may be institutionalized and even transmitted hereditarily into an aristocratic lineage. But rank depends almost entirely upon collective power, or authority, that is, legitimate power used only for collective purposes, freely conferred and freely withdrawn by the participants. Thus high rankholders have status, make decisions, and use material resources on behalf of the whole group, but they do not possess coercive power over recalcitrant members and cannot divert the material resources of the group to their own private use and so make it their "private property."

This type of organisation is especially relevant in times of ecological crisis, food insecurity, or other circumstances of scarcity of vital life resources. The distribution of resources in Gaelic and Bedouin organisations to where they are demanded is necessary for leaders to gain support. This is quite the opposite of what is seen in Mann's last stage of organisation, civilization, where he states, "they inaugurate a jump in human collective power over nature and over other humans...", which was seen in the Church, English, and Mamluk organisations.

Both the Gaels and the Bedouin held the oral tradition in high esteem, above that of the written word, which has important consequences in their capacities to institutionalise education and language. Goody explained the esteemed written word are set and cannot be altered, which the authority in power serves as the head of the knowledge economy, whereas those in the oral tradition are part of the interpretive process (Goody, 2000:130-131). As such, the oral tradition fosters greater intellectual understanding, as seen using Bloom's Taxonomy of Cognitive Levels, which shows the lack of boundaries to higher level thinking that canonised written words possess that largely limits people to Knowledge level understanding ("involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting"). The oral tradition requires different connections be made by the orator in order to connect with his audience so what he/she is understood and appreciated. This freedom for individuals to make a point to illustrate a societal held belief, in a

way he/she feels fit shows the lack of a centralized knowledge economy that can be controlled and institutionalised.

Van der Leeuw's *What drives socio-environmental systems regularly towards a crises?* noted "The Potential of the System" in sustainably expanding ecosystem services (as food) needed by a population, which the flexibility and adaptability of the Gaels and Bedouin allowed taking resources from different sources, depending on what resources were most advantageous to acquire. The resources would then be distributed to its members and unlike the powers they lived under, they would not accumulate luxury goods, undertake large building projects, or hire large administrative staffs to address the issues that these larger governments had. Van der Leeuw's second point, on the "connectivity between [organisational] levels and the internal control variables and processes" were generally strong for the Bedouin and the Gaels as problems were often dealt with, at least in part, by those that personally encountered the problem. These clan/tribal organisations made it more accessible for problems to be addressed directly to the leadership and then often times the leadership would give the means to address the problem by those that had direct knowledge of the situation. This made the system more adaptive to whatever the circumstances were and gave the means to deal with the situation more efficiently. This alleviated the problem Tainter observed of increasing complexity of the organisational system that typically "reaches a point of declining returns."

6.14 Assessing Vulnerability for a Human Zoonosis Epidemic under the systems and institutions under the Church, the English Kingdom, and the Mamluk Empire

The question of human vulnerability of zoonotic epidemics as the Plague needs to be assessed in terms of biological and ecological data of a particular region. However, if human activity is responsible for many of the changes that affects human risk of contraction of zoonoses, then it is imperative to understand the systems and institutions behind such transformations that leads to increased or decreased vulnerability. This chapter has taken a wide approach based on socio-

economic system change, particularly in the development in the Mamluk Empire. The construction of the Mamluk Empire made it possible for Arabs to unite in order to expel the Frank advances during the first Crusade. This empire was largely greatly influenced by the Europeans that they were attempting to drive out of their lands, particularly the Church and the secular national governments, in their attempt to fund and sustain a large military and defensive apparatuses. Using Table 1 from the Methodology chapter, the seven points of inquiry will be used to review the vulnerability of the systems and institutions under the Church, the English Kingdom, and the Mamluk Empire, focusing first on the points of biological and ecological emphasis and then that of the socio-economic realm. The biological and ecological points of inquiry, as seen in points 1-3 on page 48, will be first addressed through McMichael's, Begon's, and Laudisoit's risk factors for a human zoonotic epidemic.

Begon's first factor for vulnerability of a vulnerability factor for a zoonotic infectious disease, *Increase presence of emerging infectious disease in wildlife* would be difficult to gain proof of due to, however we can see evidence for an increase opportunity for this to take place in Europe and the Mamluk Empire. Specifically, it has been shown that an increase of rodent population density dramatically increases the chances for infections of the bacterium, *Y.pestis*, to take hold within that population as well as being passed on to people in close proximity to these rodents. The importance of rodent density has been shown to be a key factor for the spreading of zoonotic disease, as Meerburg *et al.* (2009:252) explain, "An increase in rodent density has proven to be important for dynamics of pathogens (Olsson *et al.* 2005:315), sometimes even more important than vector abundance (Telfer *et al.*, 2007:413)." There is also a potential connection here to rodent burrows, pathogens as *Y.pestis*, and ploughed soils. Formerly ploughed soils have been tied to a greater presence of rodent burrows, (Meliyo *et al.* 2015, p.105-119), while burrows of high densities are highly correlated to bubonic plague infection rates of the rodents and subsequently humans.

The accounts of Mamluk Egyptian agricultural fields is especially telling here as Dol summarised primary sources earlier where "... in seven days they had killed

the volume of $326 \frac{2}{3}$ *irdabbs*...Al-Maqrīzī, who puts the figure at the amount of $316 \frac{2}{3}$ *irrabbs*, states that when these officials tried to count the number of dead rats in a single *irdabb*, they found 8,400 rats in the *irdabb* and 1,400 rats in each *wayba* (one-sixth of an *irdabb*).” That is an incredible amount of rats, even a few percent of that amount is already a large amount of rats, which illustrates Begon’s risk factor, *The increased interaction of area wildlife with humans*. There is no such assessment in the European texts that pays so close attention to environmental changes, but that is not to say the same phenomenon was not happening there as the same factors to foster this phenomenon were present, i.e. large farms of cereals and grain storage as well as high density animal husbandry. Overgrazing due to high herd densities that stay in the same area for an extended period of time, which may be an increased risk with animal husbandry in settlement area (Smith and Foggin 1999:238).

The presence of large-scale cash-cropping and increasingly intense herding (which was taking place in the Mamluk and Europe in the early to mid-fourteenth century) and were also living in close proximity with the people that owned them (Dols 1977:160; (Pluskowski, Boas, and Gerrard 2011:208-209). These changes of cultivation and animal husbandry increased people’s proximity to their livestock as well as commensal animals and increased the risk of infection of a zoonotic disease, which is noted by Laudisoit’s risk factor, *Disturbance of interactions between species causing species range shifts and increased contacts with domestic animals and humans (one health)*. Additionally, the trading economies of Europe and the Mamluk Empire diminished differences among many habitats as land use prioritised the production of large herds of domesticated animals and cereals, generating similar networks of interdependent organisms across wide areas. This (along with land cover changes) would produce new environmental niches with less competition and threat of predation, allowing quick breeding opportunistic species a chance to thrive. This would seem to be an ideal situation for *Y.pestis* and its potential hosts (Biovin *et al.* 2016:6391,3692). Biovin *et al.* note that many unintended species have followed the deliberate introduction of foreign species into new lands. These unintended species would include weeds, rodents, insects, and

pathogens (Biovin *et al.* 2016: 6392), which changes the ecosystem dynamics quickly, allowing for quick breeding opportunistic species to have a population boom. These opportunistic species, which tend to have more generalized diets than most species can thrive when many other species native to the area would be starving, are more likely to be hosts for pathogens (Mills, 2006:10-12) since these animals grow quickly their immune systems are often less sophisticated and effective than slower growing animals with longer life-spans. For the context for a zoonotic epidemic to manifest, it is highly likely that some or all of McMichael's vulnerability factors for an epidemic had taken place. As noted in the previous chapter, in regards to fourteenth century Mamluk Empire and Europe, a strong argument can be made that all of these vulnerability factors were present. McMichael's risk factors consists of: *Altered habitat, with proliferation of reservoir or vector populations, Biodiversity change and habitat fragmentation, Ecosystem changes, loss of predators and host species imbalance, Intensified farming and animal husbandry, Niche invasion, and Human-induced climate change* (McMichael 2004: 1054-57). As with Europe, large-scale, cash-crop agriculture and animal husbandry would have led the heightened vulnerability in the Mamluk Empire, however, the irrigation dam system in present day Egypt was distinct and may have posed some distinct risks due to the periodic flooding and the great degree of labour that was required to keep the system operational. Borsch noted that during the fourteenth century that the dams were inadequately maintained or abandoned, which led to increased sediment loads under the dam and in the canals, diminishing the silt load in the fields and thereby flooding surrounding areas. This would have caused many rodent burrows to be flooded and thereby forces these burrowing communities to leave and rapidly find new food supplies and shelter. This may be seen in parallel to the large-scale floods seen in Europe that were caused by the large-scale deforestation and heavy rains discussed in chapter 1 and in chapter 2 (Dotterweich 2013:4), which took place during the eve of Black Death.

The cash-crop economy certainly led to a transformation of the landscape as both governments and most people depended upon cash and agricultural surpluses for their survival. The large scale herding, as with the English wool

industry, would have increased the chances for overgrazing and an increase of commensal rodents that would have served as ideal hosts for a pathogen. This can also connect with the large-scale trading of domesticated animals from the Golden Horde that was sold around Europe and the Mamluk Empire, as if these animals were infected or they brought with them commensal animals (as rodents) and may have infected the herds they went to or the commensal animal population there. This is also tied to the *biodiversity change and habitat fragmentation* (McMichael's second factor), as deforestation, clearance for agricultural fields as well as overgrazing of livestock would have led to substantial and rapid vegetation change that may have been very distinct from neighbouring lands (i.e. forested areas). *Ecosystem changes, loss of predators and host species imbalance*, (McMichael's third factor) would have been seen as these altered ecosystems were simplified for cash-crop agriculture or large-scale animal husbandry, as noted earlier, opportunistic species would often have the chance to thrive, while there also would have been the incentive for farmers to protect their crops and herds, leading to measures to eliminate many of the opportunistic species natural predators. Additionally, in regards to *Intensified farming and animal husbandry*, the close proximity of the people to their dense livestock herds would have also led to contact with commensal rodent populations, the greatest risk of which would have been with the European peasantry that slept under the same roof with their animals and would have also been in close proximity to the commensal animal communities, as rodents, that are highly susceptible to host zoonotic pathogens. The crops and animals that were cultivated were often not native to the area, as wheat in Ireland or silk worms and Mulberry trees in the Mamluk Empire in order to serve the demands of the international markets or replace what local people have come accustomed to. Species introductions often have profound impacts on ecosystems, which can lead to pushing some species out of the environment, thereby eliminating some niches that some plant and animals depend upon, leading to greater opportunities for generalist species, which are more likely to host zoonotic pathogens. Lastly, micro-, local and regional climate change due to land cover change caused by deforestation (or re-forestation), and clearance for agriculture. The forest provides a layer of "insulation" for the soil surface that led to cooler

temperatures during the growing season and also affects the transpiration and evaporation rates. Thus, McMichael's *Human-induced Climate Change* is also relevant here as the zoonotic diseases as the Plague have been shown to be effected by micro-, local, and regional climate change (Ari *et al.* 2011: 2, Leirs, 2015:105-119). Begon's last factor, *The increased potential for human to human transmission through greater population densities and increased movement both within and among different populations*, would have also been present as populations had a dramatic increase from around the start of the Crusades until the eve of Black Death, and the overwhelming majority worked in agriculture.

What fostered these vulnerabilities to accelerate through the systems and institutions under the Church, the English Kingdom, and the Mamluk Empire? The next points of inquiry will review the socio-economic systems & institutions that foster human activity that heightens vulnerability or resilience to human zoonosis epidemics, as seen on pages 330-331.

The secular and ecclesiastic powers in Europe were in competition for resource accumulation and authority over the lands, its people and their labour and activities. Ireland is an example of this, where alliances are formed, typically based upon the ones which could bring in the greatest revenue in the present and the foreseeable future. The Gaelic kings without the support of Kings of other nations that had a stronger history of resource accumulation and stable authority, would not have the ear of the Pope, which under Adrian IV, sanctioned the English invasion of Ireland. Additionally, the Irish church was quite decentralised where local clans rather than Rome had the true authority over the local institutions. Subsequent Popes generally increased the authority of the Church, as Innocent III's proclamation that the Church had the right to intervene if a king was elected that it did not like. The Canon courts and the development of law schools and universities where the Church would control these knowledge economies, gave the ecclesiastic power between nations that was unrivalled. The Church was the force that united Europe, and Latin was the language of the continent as it was the idiom of international law, trade, and education, all of which was under the Church's control.

The first Crusade forced Arab tribes to unite and develop a socio-economic system and institutions that rivalled those of their invaders. The expansion of literacy in the eastern Mediterranean was to address issues of law and demands of an administrative bureaucracy, which began to be a point of emphasis in the late Ayyubid dynasty but greatly accelerated under the Mamluk Empire. The growing institutions of academia propelled fields of medicine and *madrasah*-style lectures, which included hadith (statements and actions of the Prophet Muhammad), *fiqh* (Islamic law and the teachings of the Prophet), Arabic literature, philosophy (Walker, 2011:47-48). The boom in these professional educational institutions helped form the foundation of the trade-based economy through the Arabic language and in accordance to Islamic law. Accordingly, the focus on a standardized Arabic and practice of law put greater emphasis on the Arabic language and gave greater possibilities to those that had a high degree of literacy and writing. Education had been largely handled by one of the four schools of Islam, with the first *madrasas* was established within the Great Mosque of Damascus at the end of the eleventh century. It was also under the Ayyubids that most of the agricultural lands in Syria and Egypt were allotted to the military and administered under a local government official, which allowed the centralized government to augment its wealth and increase its control. This system system was expanded under the Mamluks, which included the most fertile lands that was directly under their control and used for sugar plantations. Accounting of resources of the lands under Mamluks for tax purposes also expanded and included the *Rawk* (of present-day southern Syria 1313-1325A.D.), which was similar to the Domesday book of England in that it established ownership of assets for the crown's tax purposes. All of this necessitates a more complex, sophisticated, and expanded bureaucracy.

The administration of taxes, the issuance of the official coin, the administration over courts and legal proceedings and law enforcement, as well as building projects and the military put greatly increasing demands upon the Mamluk, the Church, and European secular governments. As mentioned earlier, the increasing demands may be seen in the surviving papal letters, which only number ten per year under Silvester II (999-1003) but increased over time to

reach 3,646 a year under John XXII (1316-1324) (Southern, 1970:108-109). The weakness of papal authority and the bureaucracy was also seen with the seat of power being shift to Avignon from Rome. A weak, relatively disconnected Pope, as John XXII, would have lacked the authority and networks and would have struggled to keep the bureaucracy functioning enough to address issues that the Church was facing. During the twelfth and thirteenth centuries many kings influence were similarly undercut by Papal authority, if they did not adhere to his demands, leading to inefficient and ineffective bureaucracies under these secular rulers who would have been vulnerable to be overthrown by another king or an internal coup. The threat of being overthrown led many secular rulers to rapidly exploit their land's resources in order to support a strong military and enforce a strong rule of law.

Assessing the circumstances promoted by the Mamluk and English through Van der Leeuw's 'What drives socio-environmental systems regularly towards a crisis?' and Tainter's *four concepts that lead to understanding collapse*, some of these vulnerabilities become apparent. Tainter's first factor, *The Potential of the[se] system[s]* in sustainably expanding ecosystems services needed by their populations is not met. Actually, the potential of these systems to deliver ecosystem services (as food) diminishes as agricultural lands are over-exploited, diminishing their fertility, while marginal lands are also cultivated, both of which had decreasing yields from the late thirteenth century, eventually leading to many abandoned fields. This phenomena had been happening as populations were increasing.

Taxes were the main mechanism that brought governments revenue, and cash-cropping and large-scale animal husbandry was how most people generated income. The quest for more resources also brought more conflict and war, while hierarchical systems became larger and more complex as these governments increased in size and complexity. Sociopolitical systems require energy for their maintenance and this increased complexity augments the increased costs per capita. This loss of efficiency also decreases what Van der Leeuw (2009: 47) describes as the loss of "connectivity between levels and internal variables and processes" as the greater bureaucracy leads to greater gaps in communication

and connection to the problem that needs to be dealt with. An example of this is the centralisation of the Mamluk government and the administration of its lands, as the sugar plantation, where local cultivation decisions are made from a distant seat of power rather than through local decision makers. This is often done indirectly through the implementation of taxes, which force individuals to take measures to augment their rate of cultivation no matter the fertility signs of the soil. Thus, the identification of problems and the successful actions to deal with the problems that come up are going to be compromised as the size and complexity of a bureaucracy grows.

As the size and complexity of a bureaucracy continues to grow it will eventually reach a point of declining returns as the der Leeuw's adaptive capacity of a has already peaked as it becomes over-taxed with problems to deal with. Therefore, the time for problems to be dealt with increases and the outcome of problems that have been addressed is poorer as the identification and observation process is diminished and the means to include stakeholders and relevant professionals and experts in this process is more complicated with full and inflexible schedules.

Ch.7 Summary of Thesis Results and Discussion

Summary of Thesis Results

The thesis has been broken down into four case-study chapters:

-The Evolution of the Mongol Empire and the transformation of the landscape, ecology, and socio-economic systems,

*-Societal Change and Vulnerability to Zoonotic Disease Epidemics:
An assessment of the impact of escalating globalisation with a focus on Tanzania from the eve of colonisation to the recent past*

-An alternative Black Death narrative for Ireland: ecological and socio-economic divides on the medieval European frontier

-An Interdisciplinary Study of Vulnerability & Resilience of the Irish Gaels and the Bedouin of the Mamluk Frontier in Comparison to their Settler Counterparts leading up to Black Death

These chapters focus on the development of risk factors for a human zoonotic epidemic in medieval Eurasia as well as the modern example of highland Tanzania. These chapters concentrate on the risk of an epidemic of human zoonosis of the Plague in the following groups of people:

- Mongols during their expansion of Empire
- The Settlers of the Golden Horde
- Lushoto, Tanzania cash-crop agriculturalists
- The Medieval, semi-mobile Irish Gaels,
- The Medieval semi-mobile Bedouin
- The Medieval English settlers
- Medieval Mamluk Empire settlers

Using the points of inquiry from Table 1 in the Methodology chapter, the completed table below summarises the risk of a Plague epidemic with each of these groups. The inquiry questions stem from the four spheres of a comprehensive Interdisciplinary study, as stated in the Methodology chapter:

- A- 1) & 2) Ecological & Biological change through Human Activity
- B- 3) & 4) Social-Organisational and Economic Systems
- C- 5) & 6) Collective perceived authority/spirituality & collective perception of past
- D- 7) Language- Education/Enculturation

The first three inquiries will focus on *Ecological & Biological change through Human Activity*, while the final four inquiries will emphasise on last three spheres that concentrate on the development socio-economic realm. Data quality, referring to the thoroughness of data in each case study, will be broken down in the following:

- 1- Multiple ecological and biological investigations that, at least in part, cover risk or evidence of food insecurity and/or zoonotic disease on case study area;
- 2- Multiple ecological or biological investigations, but at least one of each on case study area or multiple ecological and biological investigations of a broad area or neighbouring areas;
- 3- Multiple ecological or biological investigations on case study area OR Multiple ecological and biological investigations of a broad area or neighbouring areas;
- 4- An ecological or biological investigation on the case study area and multiple ecological and biological investigations of a broad area or neighbouring areas;
- 5- Multiple ecological and biological investigations of a broad area or neighbouring areas

The Data Quality for the socio-economic inquiries for each of the population groups will depend upon the ecological/biological investigations as well as those focused on the other three spheres, *Social-Organisational and Economic Systems*, *Collective perceived authority/spirituality & collective perception of past*, and *Language- Education/Enculturation*. The Data Quality grade for the socio-economic risk factors for each of the population groups will respect the following benchmarks:

- 1- Multiple investigations, at least in part, cover evidence that either directly or indirectly would impact of food insecurity and/or zoonotic disease from each of the spheres noted above on the case study area;
- 2- Multiple investigations, at least in part, cover evidence that either directly or indirectly would impact of food insecurity and/or zoonotic disease, but at least one of each research sphere on the case study area or multiple investigations in each research sphere of a broad area or neighbouring areas;
- 3- Multiple investigations, at least in part, cover evidence that either directly or indirectly would impact of food insecurity and/or zoonotic

disease of any research sphere on case study area OR Multiple investigations of each research sphere of a broad area or neighbouring areas;

4-An investigation, at least in part, cover evidence that either directly or indirectly would impact of food insecurity and/or zoonotic disease of one of the three socio-economic research spheres named above on the case study area and multiple investigations focusing on the socio-economic research spheres of a broad area or neighbouring areas;

5- Multiple investigations, at least in part, cover evidence that either directly or indirectly would impact of food insecurity and/or zoonotic disease of the socio-economic research spheres of a broad area or neighbouring areas

The criteria for determining the Risk Factor (RF) for each inquiry for each population group will be given under the stated question. Both the Risk Factor (RF) and Data Quality (DQ) will be marked using a 1 to 5 scale. A RF of 1 indicates the highest risk and 5 the lowest risk of a human Plague epidemic, whereas a DQ grade of 1 indicates that the investigations for the case study are very thorough and conclusive while a mark of 5 illustrates the limited degree the site was investigated and thus the conclusions are not held with a high degree of confidence. Some sites have been deemed to fit in between a couple of the grading benchmarks in some of the inquiries and therefore have been assessed a .5 grade between the two appropriate benchmarks.

It should be noted that the purpose of this table is to simplify case study information to highlight the level of risk, or lack thereof, for a human zoonotic epidemic, thereby making it easier to chart the information for general comparative purposes. However, it should also be remembered that diving into the research behind the numbers is necessary to develop a plan for an area to decrease its vulnerability. The table below serves as an easy and efficient means of comparison for the populations covered in this thesis.

Table 7.1 Risk Factor Quotient and Data Quality for sites in thesis

<u>Area of Inquiry</u>	Mongols- during expansion	Settlers of Golden Horde	Lushoto, Tanzania- cash- crop agriculturalists	Lushoto, Tanzania- Traditional agriculturalists -The Shambala	Medieval semi- mobile Irish Gael	Medieval semi- mobile Bedouin	Medieval English settlers	Medieval Mamluk Empire settlers
Risk Factor (RF)– High 1-5 Low Risk Data Quality (DQ)– High 1-5 Minimal								
Data Quality (DQ) for Ecological/Biological Inquiries	DQ 4.5	DQ 3.5	DQ 1	DQ 1.5	DQ 3.5	DQ 3.5	DQ 3.0	DQ 2.5
1) Based upon the vulnerability factors for a human zoonotic epidemic, ⁵³ is there evidence of heightened risk at the site? 1-90% or above rate of applicable risk factors (of Begon, Laudisoit, & McMichael), 2-70% or above, 3-50%, 4-30%, 5-below 30%	RF 2.5	RF 1.5	RF 1.5	RF 4	RF 4	RF 4	RF 1	RF 1
2) Is there evidence of food insecurity & malnutrition/co-infections? ⁵⁴	RF 3	RF 1.5	RF 1	RF 4.5	RF 4.5	RF 4.5	RF 1	RF 1

1-Four of the following apply: a &b) evidence of malnutrition &/or infectious disease on increase in population or in skeletal remains or documentary evidence (if studying past societies), c) famine or decreasing agricultural yields for cash-crops in a society with great dependence upon them, d) mean average shows decreasing lifespans, e) decrease in physical stature, f &g) increase trend in premature &/or low birth weight babies; 2-Two of the above apply; 3-Two of the below must apply: Expanding cultivation and/or resource extraction to marginal lands, dependency on resources at an unsustainable rate, high dependency upon a few agricultural goods or natural resources; 4) One of the above factors apply; 5) Little evidence of food insecurity or infections spreading	DQ 4.5							
3) Is there evidence of deforestation, vegetative clearance, &/or erosion? ⁵⁵ 1-Palaeoecological or present-day evidence of rapid expansion of deforestation, clearance &/or erosion; 2- evidence shows a slow progression of deforestation & clearance, which may include	RF 3	RF 1.5	RF 1	RF 4.5	RF 5	RF 5	RF 1	RF 1

evidence of erosion; 3-Evidence shows occasional, intermittent occurrences of expanded deforestation & clearance; 4-Deforested & cleared areas are maintained, but with no expansion; 5- Evidence of Reforestation and bush vegetation recurrence or no evidence of either occurring within 50 years of period of investigation (sites in the distant past are more approximate in the 50 year marker)								
Data Quality (DQ) for Socio-Economic based Inquiries	DQ 4.5	DQ 4	DQ 1	DQ 3	DQ 3	DQ 3.5	DQ 1	DQ 1
4) Has there been an increasing emphasis on language built for trade over ecological observation? ⁵⁶ <i>Inquiry Spectrum:</i> 1-foreign/non-local language predominating local areas to 5:local languages predominating, which are based upon describing local ecologies- <i>Benchmark examples on Spectrum:</i> 1-A foreign language is the language of emphasis in schools, law, and many fields of study related	RF 4	RF 3.5	RF 2	RF 4	RF 4	RF 4	RF 1	RF 2

<p>directly or indirectly with the use of natural resources (e.g. business and trade of goods); 2- One language had become dominant over local languages as the tongue of emphasis in schools, law, mathematics, literature & rhetoric; 3-One language has been becoming dominant in writing within the last three generations in its emphasis in schools, law, and many fields of study related directly or indirectly with the use of natural resources; 4- There is a mix of a foreign or regional language used as well as local languages; 5- Local languages are dominant</p>								
<p>5) Is there evidence of trade/economic change leading to educational/enculturation change in society?⁵⁷</p> <p><i>Inquiry Spectrum:</i> 1-foreign dominance of local settings to 5-local dominance based on cultural geography-</p> <p><i>Benchmark examples on Spectrum:</i></p> <p>1- The instillation of an education system in a state that dominates local options and its</p>	RF 5- A	RF 4	RF 2	RF 5	RF 5	RF 5	RF 1	RF 2

<p>curriculum is set upon the agenda of a foreign nation or an international organisation that focused on literacy and rhetoric of an international trade-based language, as well as a focus on western science, and numerology/mathematics; 2- The instillation of an education system that dominates local options with a curriculum that is <i>based</i> (rather than <i>set</i>) upon the agenda of a foreign nation or an international organisation...; 3- A nation's development of its own education system that dominates local options, but whose curriculum was developed focused on the needs and circumstances of the country in the globalised world; 4- A nation's development of its own education system where a variety of local participants contributed to, and this curriculum predominates; 5- The development of multiple curriculums sanctioned within a nation, including local curriculums based upon their local cultural geographies</p>								
<p>6) Is there evidence of growth in Social organisational size & complexity, which diminished the society's problem solving</p>	RF 2	RF 2	RF 3 presently, was RF 1 during plague	RF 4	RF 5	RF 5	RF 1	RF 1

<p>efficiency?⁵⁸</p> <p><i>Inquiry Spectrum:</i> 1-Critical Societal organisations for problem solving has greatly expanded, resulting in those facing the problems typically have little to do with the problem analysis or the construction of a possible solution, to 5- Local people that are confronted with problems are also leaders in analysing the problem and constructing the solution-</p> <p><i>Benchmark examples on Spectrum:</i></p> <p>1-Centralised bureaucracy dominates assessments & solutions of local area problems, with little or no local contribution; 2- Centralised bureaucracy dominates assessments & solutions of local area problems, but with local agents part of the process; 3- Centralised bureaucracy and local governments work together to assess problems & solutions with both entities needing to approve actions before they go forward; 4-Local governments given control of local assessment of problems as well as designing the solution(s), just pending final approval be central government</p>			epidemics					
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5-De-centralised organisational system of cooperating local governments that can illicit assistance and their cooperation in identifying and addressing problems that come up, or may identify and deal with local problems internally.								
<p>7) Is there evidence of societal instigation of an ecological crisis through unsustainable socio-economic systems and institutions?⁵⁹</p> <p><i>Inquiry Spectrum:</i>1-Many levels of social organisation result in an indirect ongoing assessment of the local area ecologies and are not systematically part of consideration for societal actions taking place on the local levels; 5-Ongoing local environmental analysis takes place and the results are immediately considered and are of the upmost importance in determining societal actions-</p> <p><i>Benchmark examples on Spectrum:</i></p> <p>1-Lack of a systematic inclusion of local environmental assessments in the operating procedure of a larger central bureaucracy where</p>	RF 2.5	RF 2.5	RF 3.5 presently, Though 1 during plague epidemic	RF 3.5	RF 5	RF 5	RF 1	RF 3

<p>decisions are made that trigger local actions, with or without local approval; 2-Local environmental assessments are included in the operating procedure of a large centralised bureaucracy where decisions take many months or years to make and even longer to implement and sanctioned local actions are often tied to central government's agenda; 3-Local environmental assessments and recommended subsequent actions are part of the operating procedure of a large centralised bureaucracy that systematically has limited authority to alter these recommendations; 4-Local governments are in charge of local environmental assessments and subsequent appropriate actions to undertake, though funding is controlled by a large centralised bureaucracy</p> <p>5- Local governments assesses environmental conditions on a continual basis and act accordingly to initiate appropriate actions in order to make the most sustainable use of their needed natural resources and keeping their fellow citizens best interests and health as top priorities</p>								
Total	22	17	17/12.5	31	32.5	32.5	7	11

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The highest Risk Factor (RF) was seen by the Medieval English settlers, who scored the maximum risk score, followed by the Medieval Mamluk settlers, then the Golden Horde settlers and the Lushoto, Tanzania agricultural settlers, who have in recent years substantially improved their socio-economic risk factors (from 6 to 10.5) and no further outbreaks have occurred since these changes. The lowest Risk Factor (RF) was with the Medieval Bedouins and Irish Gaels, as well as the Shambala of Lushoto, Tanzania. It should also be noted that the Data Quality (DQ) was low for the Medieval Mongol expansion and was relatively low for the Golden Horde settlers, the Medieval Irish Gaels, and the Medieval Bedouin.

High biological/ecological risk factors and socio-economic risk factors indicate an especially high risk of a human epidemic as this indicates a systematic issues that are driving the biological/ecological factors. The socio-economic factors can be seen as the engine that drives human activity that changes the biology and ecology in a way that heightens the risk for zoonotic pathogens to infect human populations on a large scale. High socio-economic risk factors without high biological/ecological factors does not represent a likely imminent human zoonotic epidemic. However, the socio-economic factors represent a systematic problem that can lead to continued vulnerability of a zoonotic epidemic(s) as well as increasing the risk for more severe epidemic(s). However, high biological/ecological factors alone may indicate that the socio-economic system is not driving the problem and external drivers should be considered.

In these case studies the difference between the biological/ecological RF grades and the socio-economic RF grades were negligible with the possible exception of the Golden Horde settlers, that had a very high risk for the biological/ecological assessment of 1.5, but just a middling risk mark of 3 for the socio-economic RF assessment. Since the Golden Horde settlements underwent a brief but rapid increase of settlements only to have the settlements fall off dramatically during the mid-14th century (Nedashkovsky 2016: 156), may indicate the need for another category that should be considered in this assessment. The rapid escalation of settlements may increase the risk that the socio-economic

organisation does not develop at the same rate, leading to a diminished capacity for the societal administration to deal with such problems. This factor was also accentuated by the fact that this was the greatest degree of urbanisation of the Golden Horde had taken in its existence, leading to a greater degree of uncertainty and an increased risk for poor administrative decisions to be made. What is also noteworthy for socio-economic research on the Golden Horde is that the evidence for this short period (late 13th to mid-14th century) is difficult to come by, maybe especially do to the dramatic downfall of the settlements during the time of Black Death.

Those populations that had the lowest risk for a human zoonotic epidemic, the medieval semi-mobile Irish Gaels, the medieval semi-mobile Bedouin of the Mamluk Empire, and presently the Shambala, traditional agriculturists of Lushoto, Tanzania. All of these groups had possessed more local knowledge of ecological systems, education and language rooted in their cultural area but they were also knowledgeable about the people and ecological systems around them, they had more control of their own destiny and less dependency on outside actors (e.g. relatively little or no taxes being paid), having established social networks and clan systems, economic dependence upon a variety of sources including generating income and savings, agriculture, hunting and gathering. These groups being relatively de-centralised also related to the need to keep more sustainable practices. While income generation may be an important part of their economic strategy, the variety of resources they are able to gain from their local ecologies is recognised as key for theirs and subsequent generations. Comparatively medieval peasant agriculturalists had a very limited means to collect a variety of resources and also had to pay sometimes debilitating taxes based on income (or the market value of the crops they produced) and therefore were forced to be very tied to cash cropping and foreign markets for their survival.

The potential impact of increasing local control may have an example with the socio-economic system changes that have recently taken place for agriculturalists in Lushoto, Tanzania that had been spurred on in part by local universities and the LEPUS research project. These actions have included

generating local solutions as farmers partaking in beekeeping to produce honey and to assist in crop production, as well as individually assessing where the Plague had been and developing appropriate actions accordingly rather than wide-ranging central government decisions, as the widespread spraying of insecticides to control the Plague that had less than convincing results (Kilonzo *et al* 1992: 324).

The need for local assessment of problems and the local means to address those problems means that assessments can be of a more continuous nature and the stakeholders are also those that will be investigating and developing solutions. Since stakeholders will take the brunt of the consequences, they have the most incentive to accurately and fully assess the environment they are living in, while also having the greatest realisation of the resources they have at their disposal in order to deal with issues that arise. Therefore, the emphasis is on developing socio-economic systems and institutions that are sustainable in order to extract the required ecosystem services and resources. These are based upon cultural geography-based knowledge and are more adaptable and responsive to changes in the environment. Intellectual integration of the knowledge and actions associated with cultural geographies should be integrated with experts that could help bring back ecosystems that have been lost and potentially even approximations of species that have been lost (through genetic engineering of DNA samples of extinct species). Interestingly, greater ecological diversity has been said to be an indicator of ancient human occupation in the Scandinavian landscape (Bradshaw consultation), thus we may indeed have a long history of manipulating our landscape. However, in the past it used to be local people manipulating the ecosystems that their lives depended upon, which led to increasingly complex and productive ecosystems. Today we have the opposite, external agents simplifying local ecosystems in order to undertake mass harvesting and exploitation of resources, leading to greater ecological risks to local inhabitants.

Discussion

Re-thinking the Evolution of Black Death

The mapping of the *Yersinia pestis* DNA (Bos et al., 2011:506-511, Cui et al., 2013: 577-582; Cui et al., 2014:177, Drancourt and Raoult, 2016) illustrates that it is highly unlikely that the pathogen during Black Death was distinct in terms of the virulence and contagiousness than the bacteria responsible for plague outbreaks today. Investigations of the ecology of the pathogen during outbreaks in human and animal populations has revealed that there have been many mammal hosts, typically small mammals (Mani and Maguire, 2009: 164-174), that have transmitted the disease to humans. Also, many narratives treat all human populations as having similar infection and fatality rates, but that is not supported by DNA, skeletal, and written evidence. The narrative that points to the Black Rat, a tropical/subtropical tree nesting rodent, became the dominant host of *Y.pestis* in Europe, which lacks tropical regions and only Spain and fringe coastal areas along the Mediterranean has subtropical areas, has been shown to be highly unlikely (Eisen, et al. 2007:530-537). Additionally, the plague typically appears and then re-appears years or even decades later in the same geographic region (Borsch, 2014:125-156; Bos et al., 2016:1-11; Carmichael, 2014:157-192; Eisen, 2008:1-14; Neeinchkx et al., 2010:102; Seifert et al., 2016:1-8; Shrewsbury 1971; Varlik, 2014:193-228; See fig.10, p.102, for example scenario of how *Y.pestis* survives between human plague outbreaks). *Y.pestis* has been shown to continue in animal reservoirs, particularly in small mammal burrows, during times without human infections, and the pathogen has also been shown to have the capacity to live in soil, as the soil of rodent borrows as well as in dead rodents for long periods of time (Ayyadurai et al. 2008:2865-2871; Benavides-Montaña and Vadyvaloo 2017; Richgels et al. 2016).

The pathogen has been known as one that spreads slowly in the modern outbreaks and there is no biological evidence that the biology of the bacteria supports its rapid dissemination. Thus, the spread of *Y.pestis* before Black Death must not be assumed to have been a dramatic expansion immediately preceding the event. Adhering to the biological evidence through DNA samples as well as infectious disease ecology, this work argues that the 'Big Bang' of *Y.pestis* was connected to the rapid expansion of the Mongol Empire during the early to mid thirteenth century, at which time settlement areas as in western Asia, Eastern Europe and/or the eastern Mediterranean may have been locations where the

pathogen started to spread in the domestic and/or commensal animal life. The Golden Horde seems to be a strong candidate for how this occurred with the rapid increase in settlements starting in the late 13th century. This would have forced huge herds to settle in the same area, as animal husbandry was their main business. This accompanied some deforestation and the hunting of animals such as the marmot (Nedashkovsky, 2014; Ronkin, Savchenko and Tokarsky, 2009:283-284), which is a well-known host of *Y.pestis* (Qian *et al* 2014). The population used to sell its fur and eat its meat (one of Laudisoit's risk factors for contracting zoonotic disease). It is also telling that the settlements dramatically diminished during the period of Black Death. Therefore, it seems very feasible that *Y.pestis* crossed the animal-human barrier in the Golden Horde. However, the real risk may have been the huge animal herds that had been documented by multiple sources. These were of an unprecedented size and these animals were being sold for very cheap prices around Europe and the Mamluk Empire. Thus, it is reasonable to assume if these animals and the commensal animals, as rodents, that follow them were infected with the pathogen then the bacteria would travel to the lands of the purchaser and infect other animals and humans. The population density of people was much higher in rural Europe and the Mamluk Empire, and many European peasantry actually slept under the same roof with their animals. Unlike the Golden Horde, the system of agricultural settlements was well established in these areas, especially in Europe where the manorial system had been established one or two centuries before in many regions.

DNA evidence shows the present *Y.pestis* pathogen to be very closely related (including in the degree of vitality and contagiousness) to that of the Black Death (Bos *et al.* 2016:1-11; Bos *et al.* 2013 ; Cui *et al.* 2013: 577-582; Drancourt and Raoult 2016:1). Therefore we may also take clues from more recent Plague epidemics that typically re-appear after years, even decades in the same geographic area (Ayyadurai *et al.* 2010; Eisen and Gage 2009; Houhamdi and Raoult 2006; Meliyo 2014:6; Piarroux *et al.* 2013). The same phenomenon is found in the historic record (Borsch, 2014:125-156; Carmichael 2014:157-192; Eisen, 2008:1-14; Shrewberry 1970; Seifert *et al.*, 2016:1-8; Varlik 2016), and investigations have found that after a Plague outbreak the pathogen often still lives in animal reservoirs and possibly anthropogenic soils that had been used

for cultivation or other human activity. Thus, there is no reason that the spread of *Y.pestis* had to be directly before the mid-14th century pandemic, rather, judging by modern outbreaks, the more likely scenario is that the pathogen had been present in animal reservoirs well before the human manifestation of the disease.

War & Insecurity instigating greater centralisation of power, the development of the institutionalisation of knowledge, expansion of trade & homogeneous landscapes with the development of malnutrition & disease

The Crusades brought large-scale war to the European-Eastern Mediterranean Middle Ages. This demanded the development of wealth and food supplies to increase military effort and the socio-economic systems to support it. The Church had the moral authority, as well as the means to legitimise the written word over that observed in nature through the Pope and the ecclesiastic hierarchy. This was exemplified by Innocent III's *Decreto Venerabilem* (See p.314) that illustrated the confidence of the Holy See in the early thirteenth century, nearing the climax of the Church's power and influence. The Church also developed the intellectual apparatus to train administrators in letters and numerology in order to be able to successfully centralise its legal authority and its purse. The growth of ecclesiastic and secular manors from the eleventh to the thirteenth centuries served as the breadbasket of the system, and with their expansion came greater deforestation and clearance of vegetation to make way for larger fields of crops (especially cereals) in demand as well as greater herds (See Fig.13, p.107), especially cattle and sheep. The detrimental effects of such actions to garner monetary wealth comes well before Black Death as Giraldus Cambrensis (1982: 34-35) illustrated before the turn of the thirteenth century, as he wrote of the difference between the great health of the traditional Gales of Ireland where "anyone born here, who has never left its healthy soil and air, if he be of the native people never suffers from any of the three kinds of fevers" and the ill health of those of colonial Irish lands, as those of England, due to the impact the labour supporting the trade-based economy. This perception is supported by the skeletal evidence, which shows an increase in malnutrition, disease, decreased stature and life expectancy (DeWitte and

Hughes-Morey. 2008; DeWitte and Hughes-Morey. 2012; DeWitte and Slavin, 2013; Power 1994:95-118; Power 1985:49-53).

The labour required for the agricultural expansion to the thirteenth century was intensive, and thus populations grew in size and density (See Fig. 55, p.212 for general population trends in Europe relative to deforestation). As the woodlands were incrementally cut down, the fragmentation of the forest pushed the wildlife into greater contact with people and their domesticated animals (See Fig. 11, p.104, on common routes of transmission of zoonotic disease in human populations). Additionally, commensal animal life would have grown dramatically as these generalist species would have thrived as many ecological niches dwindled, which would have diminished the population of many animal species (See p.259-262). The farming one or very few crops in large fields, the storage of grain, and the intensive grazing of large domesticated herbivores (leading to more grass varieties rodents could digest that large domesticated animals cannot; See Fig.50, p.205, on relationship between density of marmot population and degree of pasture degradation) led to population booms of many generalist species of burrowing rodents.

The Crusaders taking over parts of Levant forced greater unity of Arab tribes in order to organise a successful resistance. This threat to be taken over by the Franks prompted a large united backing of Sultan Saladin that led to the establishment of the Ayyubid dynasty. This dynasty established successful resistance against the Christian invaders, which was built upon by those that overthrew them in the establishment of the Mamluk Empire. The Empire continued the Franks sugar plantations and occupied the castles they built as well as making use of other building projects (infrastructure and defensive structures) that they left behind. The Sultan based in Cairo was the centre of authority politically, economically, socially, and morally (as he could choose between the four schools of Islam based on his needs). Just as in Europe, administrators were being trained in letters and numerology to support the trading economy and to give the Sultan the means to govern a large empire. However, in the Mamluk Empire it was the secular rather than the religious leader that had the most power. Thus, tax revenues were fallen in nicely to the Sultan's coffers as trade expanded and cultivation expanded and intensified,

which had been necessary to cover military expenditures. However, local resistance was difficult to push back upon as those perceived as many Bedouin were mobile and involved in different facets of the economy, as agriculturists, herders, and traders.

Disunity and instability in Europe and the Mamluk Empire meant greater support for military intervention was needed, which results in more intensive agriculture and resource extraction to fund the initiative. Additionally, the irrigation system in present-day Egypt required a great deal of labour to maintain, which was undermined by raids (Borsch 2005:51). Thus, soils become less fertile over time as sustainable practices were overshadowed by short-term threats to stability for large centralised bureaucracies as seen in medieval Europe and the Mamluk Empire. However, those with greater decentralised networks that function as supply chains to those in need, and greater mobility and awareness of where to find needed resources and advantageous alliances had good prospects for survival and expansion. The raiding Irish Gaels and the Bedouin of the Mamluk Empire were perceived to thrive during the fourteenth century (See p.301-304) when those more controlled by secular and ecclesiastic authorities, as the peasantry, were struggling as tax burdens increased and agricultural yields decreased, while court systems held each individual responsible for his/her harvesting outputs (DeWitte *et al.*, 2016:2; Dols 1977:161; Van Krieken 2011:38-39; Walker, 2014:36).

The case of colonial and post-colonial highland Tanzania offers similarities with war leading to dramatic socio-economic and intellectual changes that resulted in a homogenising effect on human activity and the regional ecology, as well as the more traditional Shambala people with a greater ecological tie thriving. The German scorched earth military practice and the German and British development of mining and agricultural practices focused upon commodities led to greater deforestation/fractured forests, cash crops as tobacco and sugar that diminishes the soil's fertility, as well as other cash crops and large-scale animal husbandry. Diseases as sleeping sickness, which grew in the wake of cleared forest led to the expansion of an infamous host of the disease, the tse-tse fly, while more rice fields led to more breeding ground for the infamous host of malaria, the mosquito. Migration of the population to different

regions of the country, especially during Nyerere's re-distribution of agricultural lands, in order to satisfy demands of a trade-based economic system following international market demands disconnected people from the lands they knew. Additionally, the establishment of colonial and post-colonial schools focused on literacy, often of a foreign language, English, increased in importance as the realities of a trade-based economy became more evident, as the perception of reading foreign markets became a higher priority than observing their own ecological systems. This globalised enculturation, migration and people's fundamental tie to the cash economy to pay for their own needs rather than the traditional tie of people's actions being connected to the ecologies they depend upon had continued to become normalised. It has been seen as important for people's livelihoods as well as that of future generations and therefore has been a great shift that left ecologies systematically vulnerable to over-exploitation. The result was not only unsustainable ecological systems, but malnutrition and disease seen in the animal life and the people. This was not just a phenomenon seen in Tanzania but also in Europe and the Eastern Mediterranean.

The importance in the enculturation of incorporating languages that were not based in a particular cultural geography (i.e. Latin, Arabic, and English) and having the written word and measurements simplified based upon numerology/mathematic calculations for the market factors for resources (i.e. weight, mass, market price) supplant ecological observations. These analytical tools have served as the intellectual foundation for the disconnection to the ecologies that people ultimately depended upon. As Kaye noted, the cash economy brought about a profound intellectual change in how ecological systems and their resources were observed. Thus, an accumulation of cash became the way of perceived security and influence, which required the extraction of resources to obtain. The fact that was often done by unsustainable ecological practices faded in importance in the social consciousness, as there was little reward for sustainability. If lands were over-exploited that just meant more lands were needed to exploit. This is the context that generalist species, often commensal species, boomed and burrows overflowed to become ideal homes for pathogens to flourish. The natural barriers between animal life and people diminished as the intensity of the resource exploitation grew, resulting in

greater demands for human labour and thus population densities homogenising the landscape for generalist and/or commensal species to live along side them.

Qualitative-based, Comprehensive Interdisciplinary Case-Study Approach

The purpose of researching case studies using qualitative data in this thesis has been to avoid errors that a single-field approach is more likely to have (Boradkar, 2017:466). Different fields have different data and evidence that is being studied and their own theories and methodological processes to analyse what is found. Thus, distinct fields of study may spot different errors than each would find in their own discipline. This is the reason for the comprehensive approach of the four spheres used for interdisciplinary research presented here. Each of these spheres, which have been broken down into sub-spheres, covers a distinct area to be analysed and therefore requires different data/evidence, as well as theories and methodological processes for their analysis. Accordingly, the results that do not match up with the results of the other spheres may be subject to critical scrutiny.

The use of qualitative evidence over quantitative data provides more depth to the research. Analysis focuses on each unique case study, which may have many similarities to other case studies, but there are always differences and these differences can be huge factors in the results. This is something quantitative research cannot do, but rather generalises based on what is thought to be an important variable (or variables). If some results seem problematic there is not much data on a particular site to go back to and analyse whereas in qualitative research there is much to go back to and analyse. This often the case in complex cases in medicine, infectious disease epidemics, ecological crisis, community case studies, social work and psychological analysis, and special education. In complex cases it is qualitative research that has been seen as superior to quantitative as there are many factors to consider and how they interact with other factors and the context that the individual or community find themselves in. Ecosystems, biological organisms, the human mind are all examples of ever changing, very complex systems that effectively and sustainably solving a problem within them is not going to require a more in-

depth understanding of how the systems function and knowledge of what has been taking place within them. This is the realm of qualitative research.

The reason for developing a qualitative case-study based model is to try to highlight potential problems before they happen, and to do so in a way that is not dependent upon specific variables, but rather certain changes that occur that could have been caused by different variables or combinations of variables. Through this type of modelling based on the changes that occur rather than tracing specific variables, we can more effectively learn from past changes and have a stronger grasp on what breeds greater vulnerability, as well as resilience and sustainability. When a crisis occurs we can study what lead up to the crisis and form a database of similar types of crisis as well as those areas in similar settings that have not suffered a crisis or has not suffered one for an extended period and decipher why that may be the case. Through this type of analysis recommendations for more sustainable, resilient practices can be given to assist regions that are of high risk for a crisis. This is not something that quantitative research is equipped to do as those areas deemed to be in higher risk are believed to be due to the presence (or lack thereof) of certain variables, which may be sufficient for certain situations, but as the problem becomes more complex this methodology becomes more inadequate.

The promise of Palaeoecology, DNA analysis & the Potential Diminished Dependency upon the Written Record

The development of scientific methods of palaeoecology and DNA analysis means that researchers of historic epidemics are no longer limited to surviving historical records that supported large bureaucratic governments, and whose survival is rarely complete. Now we are able to gain biological and ecological data directly rather than depending on interpreting past authors' interpretations. Previously historians of epidemics were often not asking the environmental and biological questions we are searching answers for. This is especially an issue in the European historical record as the written word, numerology, and the authority of the Church diminished the authority of environmental observations.

The cash-economy gave reason for people depending upon cash for their needs to think of natural resources in number measurement terms (indicating weight, quantity, and/or bulk). Trade-based languages, as English, Latin, and Arabic are not tied to any specific cultural geography, as languages traditionally had been. Rather, it was the rule of law and the knowledge economy, which was developed by the Church and headed by Papal authority, that had a high degree of intellectual control. Knowledge that fell outside of the Church's teaching was increasingly treated as heresy as Black Death approached. It is this system that gave birth to academia, where only those with a degree in the academy are truly respected as worth citing, as direct observations of the natural environment lacked authority. Therefore, indigenous knowledge based upon their cultural geographies have been marginalised and largely discredited. This research seems to indicate that comes at a cost, an increase of human activity that leads to environmental instability, through rapid change, leading to a greater risk of human zoonotic epidemics.

It is hoped this research will help foster more sustainable environmental practices through more sustainable and resilient socio-economics systems and institutions. It is also hoped that this initial assessment tool will be further tested and refined so that it may be used to assess the risk of a human zoonotic epidemic at different locations around the world and give recommendation in order to increase the society's sustainability and resilience to zoonotic disease.

Future Research

The areas where the Data Quality was assessed as lower in this study indicates a need for further research. For instance, further research to bring about a more thorough understanding on the impacts of the Mongol Empire and the Golden Horde socio-economic systems and institutions on the local ecological and biological systems as well as the changes in their capacities to address ecological and societal problems would be beneficial in gaining further understanding with the possible link of *Y.pestis* and the Plague with these states. Furthering palaeoecological and DNA research on the past will also illuminate much that is not known through history and limited archaeological architectural evidence for those as the more mobile Gaels and Bedouins. Palaeoecological and DNA

research also diminishes the dependency on documentation of outsiders on a people that depended on the oral tradition rather than written script. Additionally, these fields have much to contribute to our understanding of interface between economic and ecological systems of the past, which can be illuminate our understanding of sustainable and resilient economies.

Greater research is desirable on the knowledge and functioning of socio-economies that operate within their cultural geographies and how this is incorporated into diet, ecosystem harvesting and their movements/changes in ecological dependencies. The importance of understanding the toxicity of plants as a defence against predators (as lactines, with gluten is the most publicised example) (Gundry 2017) and how this knowledge is interwoven with socio-economic systems and institutions is an understudied realm, which could give us greater insight into our present common health problems. The evolutionary approach to plant defences highlights the nutritional importance of a society knowing its cultural geography as knowing what fruits or vegetables are helpful for what ailment, when different fruits and vegetables should be picked and eaten as well as where the plant toxins are that are intrinsic to plants defences. Another potential research area is to study the effect of ingesting foods outside of a communities' cultural area on their health. If the people's biological systems were not used to digest certain foods then there are more likely digestive issues and other problems that may occur. Biological evolution to accommodate different foods may take many generations. Are there some regions where the people's biological systems are less accommodating than other regions? These questions link with understanding local areas and area ecological systems and the knowledge they bring. This along with having local knowledge of other ecological systems and distinct geographies could be a significant factor in developing resilience. Additionally, learning more about the knowledge systems of a cultural area and what the strengths and weaknesses are, and how we can incorporate different knowledge systems to increase sustainability would be useful. It is, after all, our knowledge and thoughts underpin our actions. Thus, if human activity is responsible for increased environmental crisis and zoonotic disease epidemics, then we must start by addressing the intellectual foundation.

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