

The role of impact assessment in the development of urban green infrastructure: a review of EIA and SEA practices in Thailand

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Impact assessment (IA) processes can potentially play important roles in driving green infrastructure (GI) planning and design, as well as establishing how GI can contribute to environmental planning objectives. In this paper, we explore how IA (strategic environmental assessment – SEA and environmental impact assessment – EIA) can support the development of GI in Thailand. A framework is designed which is used to reflect on how IA addresses and integrates GI in development at strategic and project levels. Based on a review of 18 EIAs and 4 SEAs from Thailand, it is established that whilst the consideration of GI in SEA (which is not yet compulsory in Thailand) has remained limited, consideration of green spaces for mitigating negative impacts in statutory EIA has been happening frequently. An important reason for this is that regulatory requirements imply that EIA should consider GI (referred to as ‘green spaces’). An important recommendation arising is that GI functions should be addressed in IAs, on the one hand to integrate different policies related to GI; and on the other hand to strengthen implementation of urban GI development.

Keywords: Impact assessment (IA); Green infrastructure (GI)

1. Introduction

Green infrastructure (GI) is increasingly recognised as being able to help tackling challenges in cities connected with e.g. rapid urbanisation, environmental changes, socio-economic and political issues (Mell and Clement 2020). GI can be defined as “*a network of multi-functional green space, urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities*” (Ministry of Housing: Communities and Local Government 2019, p.67). Furthermore, it can be seen as “*a tool providing ecology, economic, and social benefits through natural solutions*” (European Commission 2013), which can “*connect people with the environment to improve health and wellbeing*” (HM Government, 2018, p.71-82), as well as conserving beautiful landscapes of national parks and areas (p.56). The emerging discussion around nature-based solutions has similarities with that of GI. In this context, it has been noted that the nature-based solution concept can encompass GI (Dorst et

al. 2019). As ‘a main component’ of nature-based solutions, GI can, for example, support the reduction of flood risks based on a capability to store water, and can provide nature-based solutions for sustainable and resilient cities (Calfapietra and Cherubini 2019).

In urban settings, GI consists of “*open spaces, vegetation, parks, lakes and water features*” where “*they provide fresh air and recreation, but they can also filter pollutants and are a key to urban ventilation*” (Cheshmehzangi and Butters 2015). ‘Urban greenspace’ is considered to be one of the key elements for “*healthy, sustainable and liveable*” cities (World Health Organization 2017). People living in cities where GI is integrated in the urban environment tend to have less stress and pursue more physical activities (Kolokotsa et al. 2020). Having accessibility and enjoying time in ‘the landscape’ (i.e. ‘nature’) allows individuals of all ages to develop their health and wellbeing (Editorial 2007).

Impact Assessment (IA), including Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), can lead to a more systematic consideration of important environmental issues in decision making (Fischer 2006). Urbanisation, resource scarcity and climate change are global challenges that can be addressed through IA (Retief et al. 2016; Jiricka-Pürerer et al. 2018; Watkins 2016). In this context, GI can play an important role with regards to mitigating negative impacts and enhancing positive outcomes (see e.g. Flicke 2010).

IA plays an important role in supporting GI planning through the consideration of development alternatives, the identification of impacts, scoping, public participation, and providing mitigation and monitoring measures (Marius et al. 2019). Mitigation measures suggested through IAs can help protect “GI assets” in terms of functionality, which may be negatively affected by proposed development, while unavoidable adverse impacts can be mitigated by providing “off-setting” measures to maintain the integrity of GI networks in surrounding areas (Watkins 2016).

GI supports the creation of ecosystem services (ESPON 2019) and public understanding of GI can be promoted through IA. Furthermore, “*IA can help shape places to provide more shared value within that place and assist place-making*” (Donaldson and João 2020, p.477). However, at present, there are very few studies exploring the integration and operationalisation of IA and GI (Clement and Fischer 2020).

This paper on IA and GI in Thailand was submitted in response to an ongoing call for papers in ‘Impact Assessment and Project Appraisal’ on ‘Green Infrastructure and Impact Assessment: Global examination of green infrastructure, urban greening concepts and projects – the role of impact assessment.’ Three initial papers coming out of this call have already been published; an introduction to the topic by Mell and Clement (2020), as well as papers on practices in Scotland (Donaldson and Joao, 2020) and India (Turaga et al, 2020). This paper is meant to go into a second batch, which will continue to investigate the roles of IAs, and explore possibilities for GI to be integrated through IA processes, as well as the potential of IAs in contributing to the development of GI strategies. In the paper, the authors:

- i) introduce a framework for examining the role of IA in GI development;
- ii) clarify the understanding of IA roles in connection with urban greening / green infrastructure by reflecting on SEAs and approved EIAs with the help of the framework; and
- iii) reflect on the potential of IA for promoting GI design and planning in Thailand.

2. Framework for examining the role of IA in GI development

This section introduces the framework used to investigate IA roles in GI development. At a strategic (i.e. SEA) level, the purpose of IA is to help protect the environment as well as to integrate environmental aspects into the adoption of plans/programmes (European Commission 2003). At the project level, IA (usually EIA) is expected to ensure that the significant impacts of projects are assessed to protect people, nature (biodiversity & habitats), physical environments (land, soil, water, climate, material assets, cultural heritage and landscape), and

the connections among them (European Commission 2014). To design the framework, we focused on studies that investigated the links of GI and IAs, the existence of relevant GI guidelines/regulations at strategic and project levels as applied in IA practice, as well as key aspects appraised in IA (see **Table 1**).

Fischer et al. (2018) developed an analytical framework for establishing linkages between green spaces and health in IA. Hislop et al. (2019) suggested that the greenspace concept can be considered for GI, providing it *“has a clear function and is managed accordingly to deliver the function, and has been designed and/or purposefully managed to provide identified functions”* (p.638). O’Brien (2019) identified GI functions in UK EIAs and found that the GI concept had been considered explicitly, in particular as mitigation measures within housing and transport development projects where a ‘sustainability message’ was evidently associated with GI.

Marius et al. (2019) proposed a concept for addressing GI in IA processes. In SEA, GI can be considered within i) alternatives, ii) potential effects identification & assessment, and iii) tiering with EIA. Meanwhile, for public participation, both SEA and EIA can provide opportunities for the involvement of GI stakeholders in connection with project, plan and programme development, supporting local green projects, and assuring public accessibility regarding the relevant information and impact on GI. Better understanding of public intention and interests towards their regional environment can be reflected via IA processes (Cadariu et al. 2005). Also, for EIA, on top of the phases of selection of options, impact identification & assessment; mitigation measures and monitoring, GI can be used as an indicator for operational environmental management (Marius et al., 2019).

With regards to Thailand, the Office of Natural Resources and Environmental Policy and Planning (ONEP 2017) emphasised that collaboration and public participation were key drivers for green space management, and that green space and urban environmental

management are suggested to be integrated with urban development planning. Fell and Sadler (1999) noted that levels of public participation include the provision of knowledge and information, getting feedback from stakeholders, public involvement and consultation, which are all performed based on various methods and approaches. It is on this basis that an analytical framework was designed for the investigation of IA roles in GI development in Thailand. This is introduced in **Table 1**. We suggest that this framework can be a starting point for the integration of IA and GI across the globe.

Table 1 Framework for investigating IA’s roles for delivering GI functions

Key elements	Key components/ opportunity to address green infrastructure considerations in IAs
1. Existence of GI/ urban green space guidance/ related legislation, plan.i.e. local regulations/ plan (ONEP 2017; Hislop et al. (2019),)	☒ Guidance for policy/ programmes/ plan/ project development
	☒ Local authority regulations/ plans for GI/ urban green space management
2. Rationality of the inclusion of green spaces in IA – to investigate GI function traced from IA documents (Fischer et al. (2018; Marius et al. 2019; O’Brien (2019); Hislop et al. (2019),	☒ Supporting ecosystem
	☒ Supporting surrounding environment (i.e. mitigating adverse impacts – pollution, urban heat effects, climate change effects)
	☒ Supporting health, human perception, lifestyles, social & economic benefits
	☒ As identified in IA or green space (GS) guidance, GS operation plans/ as required by relevant regulation e.g. national & local regulations
3. Biophysical aspects assessment (Fischer et al. 2018, European Commission 2014	☒ Climate function
	☒ air quality
	☒ noise
	☒ water/ flooding
	☒ fauna & flora
4. Social & economic (equity) aspects assessment (i.e. including human-use value & quality of life) (Fischer et al. 2018, European Commission 2014)	☒ social cohesion/ exclusion/ support
	☒ physical activity
	☒ mental wellbeing
	☒ neighbourhood environment
	☒ crimes & antisocial behaviour
	☒ improved environmental and ‘healthy’ access to services/ amenities
5. Provision of positive and negative impact assessment (Fischer et al. (2018),	☒ positive impacts
	☒ negative impacts
6. Methodological approach in IA process (Fischer et al. 2018),	☒ Quantitative
	☒ Qualitative
7. Stakeholder involvement and consultation techniques as applied in IA processes/ comments beneficial on GI design & planning (ONEP 2017; Abaza et al. 2004 ; Cadariu <i>et al.</i> 2005; Fell and Sadler 1999)	☒ Public hearing/ consultation
	☒ Workshop
	☒ focus group
	☒ Internet webpage
	☒ newsletters/ leaflets/ public notification
	☒ Interviews/ questionnaire survey
	☒ other techniques
	☒ Stakeholder comments beneficial on GI design & planning found in EA/ IA findings
8. Mitigation measures & monitoring (ONEP 2017)	☒ Addressing the functions of green infrastructure/ green space as part of mitigation measures

Sources: Adapted by authors based on the references as cited

3. Testing the framework

Key relevant documents on the most recent and current policies, plans and programmes associated with the implementation of GI, SEA and EIA in Thailand were reviewed in order to

test the framework. IA sources were key authorities' websites (see **Table 2**) that also provided data relevant to urban development and greening policies and plans.

Furthermore, Sciencedirect, Scopus, Taylor & Francis online, and Google Scholar searches were conducted, using the keywords 'green infrastructure' (GI) and 'green space', 'Thailand', and 'impact assessment'.

Table 2 Data used in the stage of applying the IA role-GI framework

Key documents	Sources
<p>Legislation, policy, plans:</p> <ul style="list-style-type: none"> - Constitution of the Kingdom of Thailand (2017) - Thailand's national strategy - Thailand National Economic and Social Development Plan - Town Planning Act B.E. 2562 - Thailand local plans (i.e. Bangkok, Rayong) - <i>Thailand regional plan</i> (i.e. east, central & northeast region) 	<p>Relevant authorities:</p> <p>ONEP, BMA , Office of the National Economic and Social Development Council (NESDC); and The Thai government gazette</p>
<p>IA documents (see also Table 5, 6)</p> <p>(1) SEAs (4 discretionary SEAs)</p> <p>(2) Real estate & housing project EIAs (developed in Bangkok (inner zone - 18 EIAs))</p>	<p>Relevant authorities:</p> <p>ONEP, and ONEP's EIA database (http://eia.onep.go.th/index.php (application Smart EIA 4 Thai))</p>

To test the framework, IA documents were reviewed, based on techniques introduced by Lee and Colley (1987) for EIA and Fischer (2007) for SEA. IAs were reviewed through scoring of key components/questions in terms of “✓” (clearly mentioned), “P” (partially mentioned) and “ - ” (not mentioned), as well as “ ? ” (unclear/ insufficient information). A further explanation is provided in Table 7.

4. Introducing the Thai context

Thailand's IA experiences

IA has been used in Thailand for over four decades, including mandatory EIA and Environmental and Health Impact Assessment (EHIA: health integrated in EIA), following the Enhancement and Conservation of National Environmental Quality Act (NEQA) no. 2 B.E. 2561 (See **Table 3**). To date, other IAs (Strategic Environmental Assessment (SEA),

Social Impact Assessment (SIA), Health Impact Assessment (HIA)) have remained discretionary and voluntary. Having said that, Thailand released guidance for SEA in 2020 (e.g. NESDC, 2020; Chanchitpricha et al. 2019).

Table 3 Development of IA in Thailand

IA on a Discretionary basis							SEA	
							:	
IA as supporting PP in IA process			SIA	HIA			:	
			:	:			:	
Law enforcement	EIA <input checked="" type="checkbox"/>		:	:	:	EHIA <input checked="" type="checkbox"/>	NEQA no.2 B.E. 2561, new content of EIA section applied; SEA introduced on a discretionary basis	New related ministerial notification for EIA& EHIA are enforced, all old versions are abolished
	:		:	:	:	:		
	:		:	:	:	:		
	:		:	:	:	:		
Milestones	1975	1992	1996	2000	2005	2010	2018	2019

Remarks: : IA as Law enforcement by National Environment Quality Act (NEQA)

Source: Based on Chanchitpricha and Bond (2020, p.160)

GI in Thailand

The importance of urban greening was firstly raised in the Thai's policy statement of the council of ministers, using the term 'public park', in the context of helping to mitigate the negative impacts of urban pollution (The Prime Minister's Office 1991). Desirable greenspace should be based on sustainable urban greening, comprising of perennial trees as the key element in an urban community; and the proportion of greenspace in an urban community should be at least 10% of the total area (ONEP and Forest research centre 2004). In 2007, a policy action plan for sustainable urban greenspace was released for the first time. This aimed at maintaining and increasing urban greenspace in specific areas. Guidance and measures were introduced in order to achieve the target of a green area of 5 m²/ capita within 5 years (ONEP 2007, p.8). This reflects the functional understanding of greenspace that it can help promoting better environmental quality in urban areas where it is accessible. This resonates with suggestions by O'Brien (2019) that GI can help support an understanding of

sustainable development.

With regards to terminology related to describe GI, the terms ‘urban park’, ‘plantations’, ‘national park’, ‘forest park’, and ‘botanic garden’ were used (Ryan and Wayuparb 2004). However, ‘Green space’ is the most frequently used, while ‘green belt’ is also mentioned in local legislation (Palacheeva 2020). ‘Green space’ represents areas covered with vegetation, either natural or artificially designed. As mentioned earlier, Hislop et al. (2019) suggested that greenspace can be considered GI when it has a clear function based on purposeful management and design. In a Thai context, ‘urban greening’, ‘green infrastructure’, and ‘green space’ can therefore be considered as GI. They all revolve around the shared core concept of promoting better quality of life of people in the city. To date, discussions on GI and urban greening in Thailand have revolved around promoting quality of life, in particular of residents in towns and cities. This resonates with suggestions made by Badiu et al. (2019) who suggested that urban GI could have a key role in influencing the improvement of urban sustainability. Interest in Thailand has been triggered by international and national strategies (e.g. the sustainable development goals (SDGs)). **Table 4** shows relevant green infrastructure terminology in the Thai policy context.

Table 4 Relevant green infrastructure terminology in the Thai policy context

Strategic policies and plans/ legislation	Green infrastructure concept as introduced/ applied/ implemented	Remarks/ References
Constitution of the Kingdom of Thailand (2017)	SD-integrated basic infrastructure (section 56) Natural & environmental resource balancing (section 57, 58) SD-integrated in local governance (section 250)	
Thailand's national strategy (2018-2037)	Promoting Sustainability & green growth based on SDGs; environmentally-friendly green space is identified as one of the strategy indicators	The national strategy 2018, p. 45-46
Thailand National Economic and Social Development Plan (12 th)	Promoting green growth & eco industry, natural resource conservation and sustainable use	
Town Planning Act B.E. 2562	Proposed framework of town planning & design aligned with national strategy, development policy and plan regarding urban and rural development towards sustainability , and conserving natural resources, environment , and cultural values	Public consultation & public participation are subject to be arranged in town planning process (section 9, p.31)
Thailand regional plan	GI concept is embedded as part of natural resource and environmental conservation ; forest area proportion is raised as indicator; along with promoting key cities towards smart cities and healthy cities	NESDC 2019

As a consequence of integrating SDGs into Thailand's national development policies and plans (Ministry of Foreign Affairs of Kingdom of Thailand 2015), urban greening has been adopted as a support mechanism in project development. This is part of the operationalisation of sustainable development at all levels (Office of Natural Resources and Environmental Policy and Planning (ONEP) 2017). Besides, the Constitution of the Kingdom of Thailand B.E.2560 (2017) established a duty of 'the state' in providing SD-integrated basic infrastructure (section 56), and maintaining the balance of natural and environmental resources (sections 57 and 58). The constitution also states that people should have the right to a good quality of life (sections 257 to 259), and that local governance shall be integrated with SD principles (section 250) (Thai Constitution 2017).

Guidance is provided for how to conserve and increase green areas, along with urban ecology development planning (The national strategy 2018). GI planning was included in the 12th National socioeconomic development plan B.E. 2560-2564 (2017-2021) and in

Thailand's 20-year national strategy. This means urban greening is encouraged not just through the SDGs but also through national strategies.

5. Results and discussion

As GI is linked with spatial planning and urbanisation, industrial, transportation and spatial planning, SEAs and EIAs of such sectors were considered. NESDC (2019) noted that 37 SEAs have been conducted in Thailand. However, not all of these are available to access online. SEAs used here are from three government authorities (SEA #1, # 3, #4) and one public company (SEA #2). SEAs investigated in this study were accessed through the relevant authorities' websites and/or supplied as requested from the relevant authorities as listed in **Table 5**. EIAs were sought from the database provided by ONEP (URL: <https://eia.onep.go.th/>). Although proponents of the EIA projects are commercial private companies, all EIAs considered in this paper have been approved by expert panels as assigned by ONEP. As such, the EIAs have been conducted by qualified consultants and follow the regulations and guidance released by ONEP and local authority legislation (see **Figure 1** and **Table 6**).

Table 5 SEAs of sectors which are linked with green infrastructure design and development

Case	Year	Title	Sector/ area	Proponent/ Consultant
SEA #1	2012	Muang Rayong district and the adjacent zones	Industrialisation	Department of Industrial Works/ Air Save Co., Ltd.
SEA #2	2013	The adjacent zones of Suvarnabhumi Airport	Airport	Airport of Thailand Public co., ltd./ Kasetsart University
SEA #3	2016	The Development of the Southern Coastal Areas	Transportation	Office of Transport and Traffic Policy and Planning/ Consultants of Technology co., ltd. (COT) & New Asset Advisory co., ltd. (NAA)
SEA #4	2019	SEA of the Rayong Provincial Development Plan	Spatial planning	NESDC, Rayong Provincial Governor's Office & ADB/ ICEM Asia

Bangkok is the most populated urban area and the capital city of Thailand. The growth of real estate and housing in Bangkok is ongoing, particularly in the inner zone of Bangkok (67.24% of 638 EIAs conducted here were approved during 2015 to 2019; see **Figure 1**). EIAs of real estate and housing projects in Bangkok were tested using the framework introduced above.

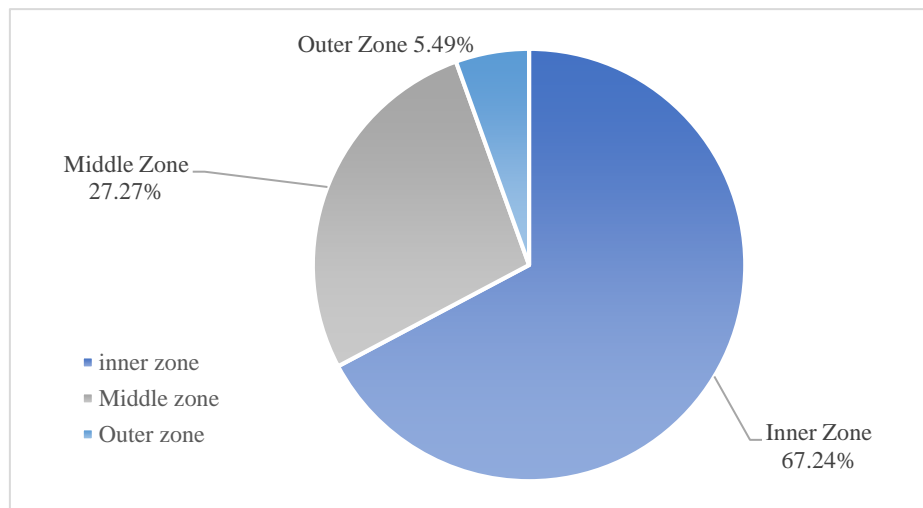


Figure 1 Real estate & housing projects' EIAs (638 cases) approved in Bangkok during 2015-2019 (as of 21 November 2019)

EIAs from projects located in the inner zone of Bangkok (comprising 18 EIAs of 18 districts) were investigated with regards to how green infrastructure is integrated. The inner zone was the focus of attention due to it hosting the majority of development projects in Bangkok (67.24%). One EIA was selected from each of the 18 districts located in inner Bangkok (**Table 6**), based on accessibility of full EIA reports on the ONEP's EIA database system (Smart EIA4Thai/ ONEP's URL). EIAs from 3 districts could not be investigated, including Dusit district (no accessible EIA available) as well as Phra Nakhon and Samphanthawong districts (no EIAs conducted between 2015 and 2019).

Table 6 EIAs investigated in this study

Project level IAs - Thai's EIAs				
Case	Year	Adjusted Project Names	Project type	Consultant
1	2015	B-Bright Condo	CHB	MITR Environment Thai (B.E. 2558)
2	2015	U-Charan 3	CHB	Environmental Technology Consultant (B.E. 2558)
3	2015	NRR 2 Condo	CHB	Kasetsart University; Natural Solution Co., ltd. (B.E. 2558)
4	2016	The E-Asoke	CHB	CMS Engineering and Management Co.Ltd.(B.E. 2559)
5	2016	B-Condo @ Sathon	CHB	Earth and Sun Co. Ltd.
6	2016	I'm C-Town	H	MITR Environment Thai (B.E. 2559)
7	2016	V-Sukhumvit	CHB	Environmental Technology Consultant Co. Ltd.(B.E. 2559)
8	2017	RHB Phase 28	CHB	Environmental Movement Co. Ltd. (B.E. 2560)
9	2017	Ideo-M	CHB	Environmental Technology Consultant Co. Ltd. (B.E. 2560)
10	2018	KNB Space Rama 9	CHB	Environmental Technology Consultant Co. Ltd. (B.E. 2561)
11	2018	Grand-S	CHB	Environmental Technology Consultant Co. Ltd. (B.E. 2561)
12	2018	NM Charoen Nakorm	CHB	Rak Dee Harm Jua co. ltd.(B.E. 2561)
13	2019	R-Phahon-Inthamara	CHB	Pro-En Technologies Ltd. (B.E. 2562)
14	2019	The C-Urban Sathorn-Chan	CHB	Environmental Technology Consultant Co. Ltd. (B.E. 2562)
15	2019	KSR Rama 3	BLC	Consultant of Technology co. ltd. (B.E. 2562)
16	2019	M-LS	CHB	Thai Thai engineers co., ltd.(B.E. 2562)
17	2019	SL Prajadhipok-Wongwian Yai	CHB	Environmental Movement Co. Ltd. (B.E. 2562)
18	2019	I-Ratchada	CHB	Rak Dee Harm Jua co. ltd.(B.E. 2560)

Notes: CHB = Common Housing Building; H = Hotel; BLC = Building, Land management & Community services

Strategic environmental assessment and GI: It was found that GI was not fully and explicitly considered in any of the 4 SEAs. Environmental aspects that were included were issues connected with noise, transportation, flooding, relocation and compensation. However, it is suggested that the findings from public involvement in all 4 SEA processes have potential to take GI design and planning into account. SEA procedures can support relevant stakeholders in exploring how GI should be planned, contributing to strategy development and

operationalisation. This is supported by Donaldson and João (2020) who highlighted that through IA processes, public understanding of GI can be promoted.

GI is embedded in SEA#1 in particular as part of eco-industrial town developments where green space capacity is considered limited. This was suggested by the SEA of the area capacity development for Mueang Rayong district and the adjacent zones Phase 2 (Department of Industrial Works 2012) (SEA #1). It was noted that factories requiring EIA or EHIA with long term operation (> 5 years) should function according to eco-industrial town indicators while shorter term operations do not need to. Recently, an SEA of the Rayong provincial development plan (RPDP) (SEA #4) was conducted by ICEM (2019a) for NESDC. Here, GI was included in the sustainability objectives (ICEM, 2019a, p49). However, the SEA established that any investigation into GI functions and purposes was very limited in the Rayong Provincial Development Plan (Ref. sustainability analysis report (ICEM 2019a).

In terms of the development of *Suvarnabhumi Airport and its adjacent zones* (SEA #2), the concept of 'ECO Airport' or 'Green Airport' was mentioned in the SEA. However, no specific GI measures were put forward (Airports of Thailand Public Company Limited 2013, p.6-29). Although the 'green airport' concept has been an aspiration since 2011 (Airports of Thailand Public Company Limited (AOT) 2011), there are no clear suggestions that GI has been taken into account.

In the Southern Coastal Areas Development SEA (2016) (SEA #3), the GI concept was embedded in environmental and social considerations as part of the formulation of the 20-year master plan. In this context, an ecosystem approach and the use of the precautionary principle were highlighted as core concepts of SD. Indicators were set for e.g. green spaces of agricultural zones, forest conservation and recovery, mangroves, urban forestry, rubber plants and agro-industry zones. The size of greenspaces in proportion to the population are considered in the underlying sustainability indicators (Office of Transport and Traffic Policy

and Planning 2016). In this context, Marius et al. (2019) emphasised that GI can also be applied as indicator in operational environmental management. Using GI (e.g. greenspaces) as sustainability indicator can help connecting strategic and project levels.

Reflecting on the most recent SEA in Thailand, SEA #4, stakeholders proposed that “green space and green infrastructure” should be stated as part of sustainability objectives for urban expansion (ICEM 2019b). This suggests that involvement in the SEA process allows stakeholders to reflect on the future of their cities, including what GI should look like. Meanwhile, the SEA process also reflected on gaps or missing perspectives of GI in the strategic development plan, and this emphasises the potential role of SEA in supporting GI in urban planning. SEA applied in different sectors considers GI differently. However, integration of GI functions are yet limited in SEA. This suggests that the IA process can help to reflect on what has been overlooked in developed policies/ plans/ programmes. Mell and Clement (2020) reported that interaction of GI planning factors, i.e. “*temporal, geographic, scalar, and disciplinary variation*”, and ‘*socio-political and economic drivers*’ influence how GI terminology is understood and applied. They also suggested that promoting ‘harmonisation’ among relevant sectors could benefit using GI in IAs.

Table 7 Coverage of key relevant aspects in the SEAs and EIAs in connection with green infrastructure/ green space concept

Key aspects demonstrated in EA/IAs	Key components/ opportunity to address green infrastructure in IAs	SEA case no.				EIA case no.																		Remarks
		#1	#2	#3	#4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1. Existence of GI/ urban greenspace guidance/ related legislations i.e. local regulations	☐ SEA/EIA guidance for policy/plan/ project development	P	P	P	P	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Discretionary SEAs; based on ONEP (2009) EIAs based on ONEP (2017a)
	☐ Relevant authority policies/ regulations/ plans/ guidance for relevant GI/ urban green space management	P	P	P	P	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	EIA cases link with Ministerial regulation on the Bangkok Comprehensive Plan B.E. 2556 (2013) and SEAs & EIAs linked with Office of Natural Resources and Environmental Policy and Planning (2017); ONEP (2007)
2. Rationality of the inclusion of green infrastructure concept/ green spaces in SEA/ IAs – to investigate GI function traced from IA documents	☐ Supporting ecosystem	P	-	✓	✓	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Implicitly indicated , green space could contribute to air quality improvement
	☐ Supporting surrounding environment	✓	-	✓	✓	P	✓	✓	P	P	P	✓	P	✓	P	P	P	P	P	P	P	P	P	i.e. mitigating adverse impacts – pollution, urban heat effects, climate change effects
	☐ Supporting health, human perception, lifestyles, social & economic benefits	P	-	P	✓	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Implicitly linked with human perception & promoting lifestyles
	☐ As identified in SEA/ IA or green space guidance/ operation plans/ as required by relevant regulations e.g. national & local regulations – proposed as mitigation measures	P	-	P	P	P	P	✓	P	P	P	P	P	✓	✓	✓	✓	✓	✓	✓	✓	✓	P	✓
3. Biophysical aspects assessment	☐ Climate function	P	-	✓	✓	P	P	P	P	✓	✓	P	✓	✓	✓	P	✓	✓	✓	✓	✓	✓	✓	
	☐ Air quality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	☐ Noise	-	✓	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	☐ Water/ flooding	P	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	☐ Fauna & flora	-	✓	✓	✓	P	✓	✓	P	P	P	-	-	-	-	P	-	-	-	-	-	-	-	Uurban ecology' is applied describing areas in the EIAs, however, deep investigation of its meaning has not been justified in the EIAs

4. Social & economic (equity) aspects assessment (i.e. including human-use value & quality of life)	☐ Social cohesion/ exclusion/ support	P	✓	✓	✓	✓	✓	P	✓	P	✓	P	P	P	P	P	P	P	✓	P	P	✓		
	☐ Physical activity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Physical activities are not found linking with the provision of green space in the project EIAs
	☐ Mental well-being	-	P	P	?	P	✓	✓	✓	✓	P	✓	✓	P	✓	✓	✓	P	✓	✓	✓	✓	✓	
	☐ Neighbourhood environment	P	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	☐ Crimes & antisocial behaviour	✓	-	✓	-	✓	P	-	✓	-	P	-	P	P	P	✓	P	P	P	✓	P	P	✓	
☐ Improved environmental and 'healthy' access to services/ amenities	P	P	✓	✓	P	✓	✓	P	P	✓	P	✓	P	✓	P	✓	✓	✓	✓	✓	P	✓		
5. Provision of positive and negative impact assessment	☐ Positive impacts	P	✓	✓	✓	P	P	P	✓	✓	P	P	P	P	✓	✓	P	P	P	P	✓	P	P	
	☐ Negative impacts	P	✓	✓	✓	P	P	P	✓	✓	P	P	P	P	✓	✓	P	P	P	P	✓	P	P	
6. Methodological approach in EA/ IA process	☐ Quantitative	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	☐ Qualitative	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
7. Stakeholder involvement and consultation techniques as applied in IA processes/ comments beneficial on GI design & planning	☐ Public hearing/ consultation	✓	✓	✓	✓	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-		
	☐ Workshop	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	☐ Focus group	✓	✓	✓	✓	✓	-	-	✓	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	
	☐ Internet webpage	-	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	☐ Newsletters/ leaflets/ public notice	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	☐ Interviews/ questionnaire survey	-	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	☐ Other techniques	✓	-	✓	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-	✓	-	-	
☐ Findings from public involvement demonstrate comments which can be taken into account on GI design & planning found in EA/ IA findings	✓	✓	✓	✓	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	EIAs – better data management of public comments will lead to more beneficial key issue for further application	
8. Mitigation measures & monitoring	☐ Addressing the function(s) of green infrastructure/ green space as part of mitigation measures	✓	-	✓	✓	✓	P	✓	P	P	P	P	P	P	P	P	P	P	P	P	P	P		

Notes: List s of EIA cases are presented in Table 4; ✓= clearly mentioned, P= partially mentioned; - = not mentioned ; @ = UGS sustainable management plan; ? = unclear/ insufficient information to justify

Environmental impact assessment and GI: In Thailand, existing guidance and local regulations have advised project proponents to ensure green space provisions are included as mitigation measures in the EIAs of real estate and housing project developments, to maintain environmental quality during construction and operation phases. **Table 7** shows that all EIAs were conducted based on suggested guidance by government authorities (i.e. ONEP 2017b), as well as relevant local regulations and plans (e.g. Bangkok Metropolitan Administration (BMA) 2013). Whilst GI development is embedded in the 18 EIAs, this is mostly implicit. Thus, it is stated that the measures on providing green space should be able to support ecosystems, the surrounding environment, and human healthy lifestyles, and that this could lead to support decision-making towards sustainable development. Watkins (2016) suggested that the mitigation measures brought forward by IA can help protect GI's functionality from adverse impacts which may be caused by development. Furthermore, connections are made with air quality improvement, through mitigation of pollution, the urban heat island effect, and climate change effects. While it was highlighted that GI can be effective in climate change adaptation; mitigation of environmental changes and environmental pollution as well as disaster risks (e.g. Derkzen et al. 2017, Matthews et al. 2015, Sussams et al. 2015), discussions concerning these matters were found to be limited in the EIAs.

The '*urban ecosystem*' was only mentioned in the Bangkok Comprehensive Plan B.E. 2556 (2013) case, but in none of the other EIAs, suggesting a gap between plan and project levels. Biological components (fauna and flora) were only rarely considered in EIAs conducted in urban settings. With regards to social and economic (equity) considerations, physical activity was not mentioned in any of the 18 EIAs. However, in project developments in urban areas, finding opportunities for promoting physical

activity can be challenging, and EIA could help to address this in connection with GI functions.

In 2012, a report presented by the Bangkok Metropolitan Administration (BMA) stated that the proportion of urban greenspace accessibility was 4.73 m²/ capita and the 2019 figure was 6.71 m²/ capita for 50 districts of Bangkok. Back then, a 20-year development plan for the Bangkok Metropolis was established and greenspace expansion was a supporting element for ‘Strategy 2: ‘Bangkok as a green and convenient city’ (Strategic and Evaluation Department BMA and Faculty of Political Sciences: Chulalongkorn University 2013). The measures in this plan were applied in providing green areas / greenspace within the project sites where new construction is located. As such, it is stated in the EIA guidelines for real estate development projects that green space management must be provided within the project area based on the green space management criteria (ONEP 2007, ONEP 2015, ONEP 2017b, Ministry of Interior 2013), and the Building Control Act B.E.2522.

Approaches to public participation in the 18 EIAs included interviews and door step questionnaire surveys. The use of other techniques was limited. A possible explanation is that projects were developed in urban zones where it is unlikely that the majority of community members can take part in meetings at the time they are scheduled (e.g. morning or afternoon hours). It is observed that the data gained from the public consultation in the EIAs could have been managed and analysed with more systematic approaches, for example, using thematic analysis or appropriate analysis for qualitative data management. Using a variation of techniques for public participation could help achieve more insights. This can be beneficial to the establishment of mitigation measures, which can help projects being more sustainable way in the long term. Abaza *et al.* (2004) suggested that it is essential to maintain the interests of stakeholders in a

continuing way to ensure the most mutual benefits for their communities. It was noted that environmental, cultural, historical, and institutional factors can influence the extent to which greenspace is developed in urban areas (Richards et al. 2017).

Referring to the experience of green space management in Rayong and Nonthaburi (i.e. ONEP 2017a), EIA processes can allow stakeholders to express an opinion on what environment they want to live in. This can include greenspace design and planning (see **Table 7**). In this context, greenspace provision is a key issue. As such, EIA processes, and associated public participation can be considered a suitable mechanism for establishing greenspace/urban greening/GI demands. Therefore, considering ways to improve opportunities for public participation in an urban context is important for supporting and promoting the desirable direction for urban development.

Monitoring measures (the consideration of which is legally required) with regards to greenspace management during the operation period were included in 17 EIA reports (including monitoring tree/plant growth and increased plantations). This is an indication that EIA legislation and relevant laws can influence greenspace management within locations where project development happens. Including GI in EIA processes can contribute to the improvement of urban greening strategies, including greenspace development policy. Although urban greening has already been integrated into various developments in Thailand, obstacles to greenspace management are issues related to specific contexts (i.e. industrial zone, commercial zone), and impacts of project development in such zones (ONEP 2017a).

6. Conclusions

The creation and application of an IA and GI framework has allowed us to reflect on the extent to which IA processes have the potential to contribute to the development of GI

and urban greening strategies in Thailand. IA processes can provide opportunities to investigate the link on how green infrastructure is potentially affected by proposed development/actions, and how people can connect with it. While there are plenty of opportunities for IA to support the development of GI, this is not yet well reflected in current practices in Thailand. Applying this framework in other settings will help develop a better understanding of IA roles in connection with GI design and planning along with proposed development policies, plans, programmes and projects. This can help to establish guiding principles for integrating GI in IA processes and practices.

To ensure that GI helps to mitigate negative environmental and health impacts, monitoring and assessment are required in terms of how green space/GI can benefit people and the environment. In this context, GI is often considered a mitigation preference in terms of its functionality for reducing carbon, mitigating floods, improving air quality, and mitigating the urban heat island effect in cities.

The findings presented in this paper demonstrate that while there is still some way to go for achieving desired outcomes, already today green space practices in Thailand aim at improving urban environments. Green space and GI do not only deliver physical 'green' characteristics, but create places where people can enjoy their time in a clean environment. Also, GI should be included in mitigation of adverse impacts in IA processes.

Environmental pollution across the globe is getting worse, and GI can play an important role in mitigating effects. In this context, it is important to maintain continuity of current practices and processes in translating GI relevant policies into practice. For Thailand, continuous improvement of more research and databases on GI and its functions are needed, along with measures to improve relevant data network connections, and collaboration, thus building awareness and knowledge.

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