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## Socio-Ecological Resilience for Urban Green Space Allocation

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# Socio-Ecological Resilience for Urban Green Space Allocation

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**Abstract.** The conceptualization of human-nature relationship in planning theory focuses only on political ecology and environmental ethics. This paper reviews the scholarly literature on the application of socio-ecological resilience in urban spatial planning and how it can reinforce ecological consideration in the demand allocation of urban green spaces as an alternative approach to the existing “standard approach” which based on population number. Based on literature review this paper reveals the importance of analyzing the dynamic interaction of socio-ecological systems (complex and adaptive) in spatial planning, especially in determining demand allocation of urban green spaces, not only able to address the challenges of “think planning again” especially in understanding the nature’s behavior in interacting with humans. This paper concludes with a discussion of how this demand might be provided and why it need to be optimized with the supply-side of urban green spaces.

## 1. Introduction

In planning theory, ecological or environmental aspect is one of determinant factor for land use planning, in addition to social and economic aspects [1], however the composition of those aspects is highly depending on development goals of the country or region [2]. Since the 1970s, the standard approach has been criticized for failing to deliver high quality parks and open space, and failed to consider changing demographic patterns, changes in leisure preferences and behaviors, and which ignored the capabilities of older and younger people [3]. That example indicates that ecological consideration in planning still remain an empty signifier [4]. As a result, the effort in accommodating human-nature relationship are replaced by managerial planning, expert management and administration [4, 5, 6].

Socio-ecological systems (SES) provide a thorough understanding on human-nature relationship. An SES is comprised of feedback among human values, perceptions, and behaviors and the biophysical components of the ecosystems in which people live, resulting in a “resilient” or “vulnerable” trajectory trending toward sustainability or collapse [7]. When planning theorists are calling for more attention to matters of substance, socio-ecological resilience provides a timely contribution with its specific attention to linked socio-ecological systems [6].

## 2. Socio-ecological resilience and its applicability in planning

Socio-ecological resilience (SER) originates in system ecology and is based on assumptions of non-linear dynamics of change in complex, linked social-ecological systems [8]. Socio-ecological resilience is the capacity of a system to absorb disturbance in order to maintain the same identity [9].



Socio-ecological resilience differ from engineering and ecological resilience, distinguished the three major resilience concepts based on their characteristic [8], as shown on table 1.

**Table 1.** The differences of three major resilience concepts.

Resilience Concept	Characteristics	Focus on	Context
Engineering	Return time, efficiency	Recovery, constancy	Vicinity of a stable equilibrium
Ecological	Buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibria, stability landscapes
Social-ecological	Interplay disturbance and reorganization, sustaining and developing	Adaptive capacity, transformability, learning, innovation	Integrated system feedback, cross-scale dynamic interactions

Source: Folke, Carl (2006)

There are five preliminary heuristic of socio-ecological resilience that describe patterns of abrupt change [10], i.e. Adaptive cycle; 2). Panarchy; 3). Resilience; 4). Adaptability; and 5). Transformability. The first two describe the dynamics of systems, while the last three are the properties of social-ecological systems [10]. Resilience is not only about being persistent or robust to disturbance, but it also about the opportunities that disturbance opens up, renewal of the system and emergence of new trajectories [6, 8].

There are some promising parallels between evolutionary (socio-ecological) resilience and the interpretive approach to planning, because both put emphasis on “fluidity, reflexivity, contingency, connectivity, multiplicity and polyvocality” [11]. That the most significant contribution of socio-ecological resilience for planning is its role as a different and useful frame for both problem-setting and problem-solving [6]. Furthermore, SER with its focus on the governance of linked socio-ecological systems, is of interest to the field planning for its ability to explore gap, issues or problem that has been overlooked by planning in understanding the relationship between human and nature [6, 11].

Resilience still need support from social theory to articulate social phenomenon such us political and power relation [12, 13]. In doing so, some researchers have incorporated social theory and SER for various purposes in planning. Production of Space of Levebre and Actor Network Theory to reveal the driver of community vulnerability and resilience in volcano prone area in Yogyakarta [14]. Production of Space of Levebre and Urban Morphology Theory to explore land-use forms in Mekong Delta in order to identify community vulnerability and resilience toward flood [15]. Critical theory to produce framework on social production of ecosystem services which outline justice or equality aspect in generating and distribution of urban ecosystem services [16]. The growing enthusiast in applying resilience thinking indicates its potential as a bridging concept between the natural and social sciences. Of course, this tool need to be tread carefully so that when trying to understand society [4, 11].

### 3. Planning for urban green space

Urban green spaces are an essential constituent of urban quality of life and as an important contributor can be a significant part of sustainable development [17-19]. The definition of urban green spaces which is agreed on by ecologist, economist, social scientist and planners is public and private open spaces in urban areas, primarily covered by vegetation, which are directly (e.g. positive influence on the urban environment) available for the users [19]. The focal issues to urban green spaces planning is determining the allocation of urban green spaces. The standard approach has since the early twentieth century guided the minimum acceptable green spaces allocation for urban residents [20]. However, research has shown that many local authorities facing development pressure fail to implement the standards [21].

### 3.1. Benefit of urban green spaces and its relation to ecosystem services

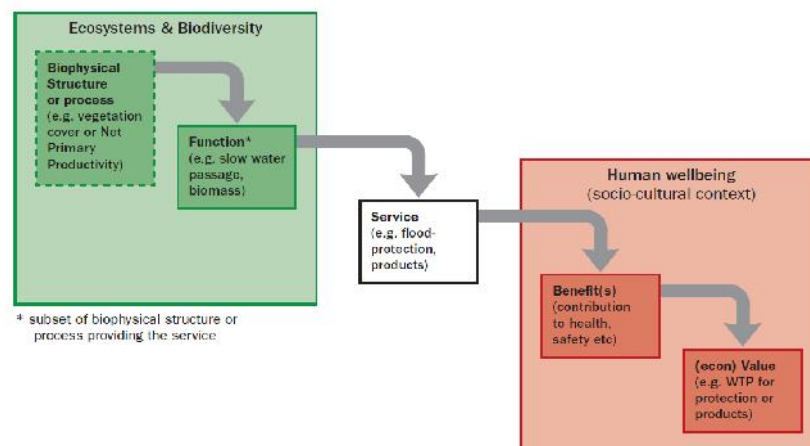
Throughout human history, urban green spaces have fulfilled many different function to meet human needs. Chronological function of urban green spaces throughout human history [22], as follow shown in table 2.

**Table 2.** Different use of urban green spaces through history.

Time period	Uses for urban green spaces
600 BC	Private power and social status
1300 AD	Innovative agriculture
1700 AD	Collective gardens for knowledge
1900 AD	Food production
2000 AD	Leisure and recreation
2010 AD	Health and ecology

Source: Leeuwen et al (2010)

Many academic literatures have discussed the benefit and function of urban green spaces to human or urban resident [19, 20, 22]. They are among other things as follow: (1) environmental benefits; (2) Economic and aesthetic benefits; (3) Social and psychological benefits [19]. Ecosystem services framework provides link to human-nature system as shown in figure 1. The concept of ecosystem services and adopted by UN Millennium Ecosystem Assessment has introduced four categories of ecosystem services as follow: 1). Provisioning services (product obtained from ecosystems like food and fiber); 2). Regulating services (benefits obtained from regulation of ecosystem processes like air and water filtration); 3). Cultural services (nonmaterial benefits obtained from ecosystems, like spiritual enrichment, cognitive development, recreation, and aesthetic experiences); 4). supporting services (ecological functions such as pollination, nutrient cycling and soil formation) [16].



**Figure 1.** The ecosystem services framework.  
(Source: De Groot et al, 2010)

In urban landscape, ecosystem services are not simply a benefit of ecosystem functioning but rather are coproduced by people and ecosystem [16, 23]. This emphasizes the need for understanding linked socio-ecological system to manage urban green spaces in order to ensure the resilient supply of ecosystem services therefore able to provide urban population demand of its benefits.

### 3.2. Challenges in urban green spaces management

Increasing urbanization is consistently blamed for the conversion of a great deal of green spaces into impermeable surfaces as urbanization requires more land for infrastructures, housing, transport networks [24]. This trend is critical to urban green spaces management, as decreasing quantity and

quality of urban green spaces will affect its performance in delivering its functions and benefits needed by urban population to improve their quality of life. three major challenges toward management of urban green spaces as follow: 1). Socio-economic and demographic factors, which relates to high rates of urbanization due to economic and population growth which lead to the conversion of agricultural land and forest into built environment in urban areas; 2). Quantitative aspects of urban green spaces, which refer to green space ratio or green space area per capita. It is very difficult to measure the appropriate amount of required land and allocation of land, and calculate distance from residential area. Table 3 shows the standards of minimum sizes of various type of green spaces in urban areas; 3). Qualitative aspects of urban green spaces, which refer to the benefits of urban green spaces which can be accessed by urban population based on their needs and preferences [19]. Those three major challenges lead to the issue of urban green spaces allocation in which influenced by urban political ecology. Political ecology provide understanding in re-creation of nature to accommodate political, ecological, economic and culture values [25], however more often the social production of urban green spaces through political ecology lead to inequality of spatial distribution, especially due to uneven property ownership and the increased marketization of nature [26]. The inequality of spatial distribution is not only issue of social justice, but also affect the sustainability of urban biodiversity through the fragmented distribution of urban green spaces.

**Table 3.** Minimum standards for urban green spaces.

Functional level	Maximum distance from home (m)	Minimum surface (Ha)
Residential green	150	-
Neighbourhood green	400	1
Quarter green	800	10 (park: 5 Ha)
District green	1600	30 (park: 10 Ha)
City green	3200	60
Urban forest	5000	>200 (smaller town) >300 (big cities)

Source: Herzele and Wiedermann (2003) in Haq (2011).

Other challenge toward management of urban green spaces is scale mismatches in governing urban green spaces, which occur when the scales of ecological dynamic and the scales of social organization for management are aligned in a way that negatively affects the ecosystem. Among other things, incomplete knowledge of ecosystem dynamics and institutional constraints frequently leads to institutional frameworks for management that do not match the scales of ecological patterns and processes [27]. Concerning scale mismatches in governing urban green spaces in Stockholm has shown that municipalities who manage urban green spaces tend to classify local green areas such as allotment gardens, urban parks, cemeteries into “developed land” and have not recognized the roles of local green spaces in sustaining ecological processes in higher level of governance processes [28]. Thus, one of greatest challenges to urban planners, landscape architects, and urban managers is to balance the tension between provision of urban green spaces for diverse function and benefits needed by urban population; and ensuring the resilient of ecosystem services supply for preserving and conserving the unique qualities of urban ecosystem.

### 3.3. Urban green spaces planning in Indonesia

In planning practice, allocation of urban green spaces is part of spatial planning processes. In Stuttgart and Tampere, prior to urban green spaces planning, a landscape planning is conducted as a basis for land use planning [29]. In Indonesia, spatial planning law and its prevailing regulations outlined the procedures in allocation of urban green spaces. As adopted by many countries, the standards approach in urban green spaces allocation is also adopted by Indonesia. However, the size of minimum standards might differ from other countries, as it stipulates through Ministerial Decree of Public Work (PERMENPU Nomor 05/PRT/M/2008) concerning The Guideline of Allocation and Utilization of Green Open Spaces in Urban Areas. Table 4 shows the details of minimum standards of urban green

spaces in Indonesia based on the decree. Furthermore, the guideline outlines several general requirements for urban green spaces allocation:

- a. The minimum amount of urban green spaces in administrative region (district/city) is 30% of the total area, which consist of 20% for public ownership and 10% for private ownership.
- b. The size of urban green spaces is calculated based on:
  - Number of district/city population (table IV).
  - Specific function such as: buffer for railways, street, and river.
  - Oxygen demand per capita (especially for urban forest).
  - Fresh water demand per capita (especially for urban forest).

As mentioned earlier, that most of local government in Indonesia has failed to meet those standards, due to various reasons but mostly the high price of urban land is a major reason why local government in Indonesia has failed to meet the minimum standards. Many local authorities facing development pressure fail to implement their standards. Outlined critiques from various scholars that argued the standards approach has failed to deliver quality parks and open space; and for producing bland green spaces that people do not use; as well as failed to account for changing demographic patterns, changes in leisure preferences and behaviours. Moreover, these standards have never been empirically evaluated or scientifically tested [21]. Along with those critiques, I argue that the standards approach has not ensured the sustainability of urban ecosystem, nor consider the dynamic of socio-ecological systems, since it applied uniformly to all regions whose socio-ecological condition might differ specifically.

**Table 4.** Minimum standards for urban green spaces per capita in Indonesia.

Neighborhood unit (people)	Type of green space	Minimum size/unit (m <sup>2</sup> )	Minimum size/capita (m <sup>2</sup> )	Location
250	Neighborhood parks	250	1.0	In the middle of neighborhood
2,500	Neighborhood parks	1,250	0.5	In the middle of neighborhood
30,000	Village parks	9,000	0.3	Grouped with school
120,000	Sub-district parks	24,000	0.2	Grouped with school
	Cemeteries	Adjusted	1.2	Distributed
480,000	Urban parks	144,000	0.3	City center
	Urban forest	Adjusted	4.0	Peripheries/fringe areas
	Specific function	Adjusted	12.5	Based on demand

Source: PERMENPU No. 05/PRT/M/2008.

However, as an alternative to standard approach, a “needs-based” assessment has emerged as the preferred techniques for forecasting and supplying urban green spaces which considers the socio-demographic and bio-physical characteristics of areas for which parks are needed, or where parks facilities will be upgraded. A needs-based assessment is better able to respond to the requirements of urban populations, and consider not only the absolute number of people within a given geographic area, but importantly also accounts for their socio-demographic composition, their leisure and recreation preferences and those of various sub-groups within this population, and the type and number of facilities required to serve those needs [21]. These considerations should also reflect projected residential densities, which can change population compositions.

#### 4. The application of socio-ecological resilience for urban green spaces planning

Recent research has revealed that the lack of interest in green spaces is expressed by a sharp decline of cultivated plants in public and private green spaces, indicating that the sustainability of urban ecosystems is at stake [30]. Socio-ecological resilience provides a timely contribution with its specific attention to linked socio-ecological systems in providing the understanding of contemporary human-environment interaction issues in urban green spaces. However recent studies on urban green spaces



focus mostly on one benefit or related specific benefits of urban green spaces [30]. Therefore, there are five emergent future research agenda in urban green spaces as synthesized by reference [31] as follow in order to provide complete understanding on human-environment interaction issues in urban green spaces: (1) The physicality of urban green spaces; (2) The experience of urban green spaces; (3) The valuation of urban green spaces; (4) The management of urban green spaces; and (5) The governance of urban green spaces.

Therefore, resilience planning for urban green spaces need to answer 5W (what, who, when, where and why) questions to prioritize which functions and benefits of urban green spaces will be prioritized and where? who can access them? Table 5 is an example of 5W answer to prioritize function and benefits of urban green spaces in resilience planning.

**Table 5.** Illustrative application of the “five W of urban resilience to urban green spaces planning.

		<b>Scenario 1</b>	<b>Scenario 2</b>
Who?	Trade offs	Beneficiaries are city residents living in flood risk zones	Beneficiaries are city residents with most limited access to green space
What?		Specifically focused on storm water management	Generic community resilience
When?		Focused on current residents and based on current estimates of risk	Both short-term and long-term resilience
Where?		Neighborhoods with the most area in flood hazard zones within the municipal boundaries	Neighborhoods with the lowest average access to green space within municipal boundaries
Why?		Goals is an outcome: flood losses and investments in “gray” storm water infrastructure are reduced	Goal is an outcome: increased social justice.

Source: Meerow & Newell (2016)

Resilience thinking in planning requires a precautionary determination in deciding resilience of what, to what and for whom? Because prioritizing resilience benefit of urban green spaces (e.g. storm water abatement) over another (alleviating park poverty) could lead to markedly different spatial priorities, with implications for a city’s ecology and socio-economic fabric that could lead to exclude a certain urban population in accessing the benefits of urban green spaces. Therefore, stakeholders’ participation in answering 5Ws questions is needed [32].

Furthermore, there are characteristics of resilience system that need to be achieved through resilience planning. Five characteristics to build urban resilience, they are: multi-functionality, redundancy and modularization, (bio and social) diversity, multi-scale networks and connectivity, and adaptive planning and design [33]. The relationship between urban green spaces and these resilience characteristics is often focused on storm water management. In particular, urban green space has the potential to reduce dependence on centralized storm water infrastructure, based on the rationale that decentralized systems are more modular, provide functional redundancy, and are therefore less vulnerable to catastrophic failures [34]. This suggest the need for future research to explore the benefit of urban green spaces that could generate another resilience characteristics. Resilience approach in conceptualizing demand side of urban green spaces has been conducted by several researchers [34]. However, optimizing supply-demand side of urban green spaces still require a thorough understanding on driver and barrier from social practices. This suggest a need for future research to scrutinize resilience-building framework for planning decisions of urban green spaces allocation.

## 5. Conclusions

Cities and urban areas are under threat of climate change and associated extreme events, such as drought, flood, heat waves as well as confronted with a mix of growing challenges from population growth that outpaces infrastructure development, growing slums and informal settlements, social inequality, and other stressors [23]. Those challenges and pressures to cities and urban areas require a non-business as usual of planning practices which tend to focus on procedural aspect of planning instead of promoting social-ecological substances in responding various vulnerabilities of urban

system arising from those pressures. One of the evidence on business-as-usual of planning practices is the procedure on urban green spaces allocation still use the standard approach which based on population number, instead of a thorough analysis on human-environment interaction dynamic in urban landscape.

This paper introduces socio-ecological resilience approach with its specific attention to linked socio-ecological systems as an alternative approach for urban green spaces planning. We divided the discussion into three sections: socio-ecological resilience its applicability in planning, planning for urban green spaces especially in Indonesia along with challenges in managing urban green spaces; and explores and analyzes the application of socio-ecological resilience for urban green spaces planning and discuss why supply-demand sides of urban green spaces need to be optimized within socio-ecological resilience context. This suggest a need for future research to scrutinize resilience-building framework for planning decisions of urban green spaces allocation.

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