

Small urban parks and resilience theory: how to link human patterns and ecological functions for urban sustainability

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The purpose of this essay is to discuss the relevance of the literature presented in the course Urban Ecology as Science, Culture and Power for my PhD research project. All literature is interesting, but in this essay I elaborate on some of the ideas and arguments that have really inspired new steps in my project. My PhD project's working title is 'Ecological Resilience of Small Urban Parks: System Functionality and Adaptation to Disturbances'. The aim of the project is to assess the resilience of small urban parks based on social-ecological system performance in a high density city in Malaysia.

I structured this essay into four main sections. The first section – on *urban parks and small urban parks* - refers broadly to the characteristics of urban parks in general, their importance and issues pertaining to them. These will then be developed into a discussion of small urban parks and how these differ in terms of spatial and functional characteristics. The next section- on *ecological resilience of urban green spaces* – focuses on the application of the resilience concept in an urban context and particularly as related to managing small urban green spaces. The pros and cons of the ecological resilience approach for small urban green spaces will be discussed. The third section focuses on a *social-ecological approach* as a framework for analysing and developing small urban green spaces. The relation between park sustainability and urban ecosystems is addressed through making the case for the value of small urban parks as provider of social services that are essential to the quality of human life, which in its turn is a key component of sustainable development. The final section discusses on the role of *political ecology* in policy and decision making and governing for urban green spaces.

The essay concludes with reflections on how sustainable small urban parks can be realised through integration of ecology in urban planning and design. Despite the fact that park ecology is important for urban ecosystem and biodiversity, balancing ecological and social needs in small urban parks is crucial and will promote citizen's well-being and sustainability of the city they inhabit.

The importance of urban parks and small urban parks

Urban green space refers to all open vegetated areas within the urban environment and consists of parks and recreational spaces, gardens, lawns, brownfield and wasteland areas, and woodland (Francis & Chadwick, 2013). Parks, as one specific type of urban green space, are recognised by many as important elements to make the city liveable, pleasant, and attractive for its citizens and as important habitat for diverse species in the cityscape (Chiesura, 2004; Neilsen, et al., 2013). In the theory of urban park geography, parks are viewed as islands of relatively distinctive land use and value surrounded by a 'sea of urban development' (Brown, 2008). Urban parks are defined as delineated open space areas, mostly dominated by vegetation and water, and generally reserved for public use. Parks are mostly larger than other urban green spaces, but they can also take the shape of smaller 'pocket parks' (Konijnendijk, et al., 2013; Neilsen, et al., 2013). The term pocket park is used to describe small and compact urban green spaces – i.e. small urban parks (Nordh & Østby, 2013). Small urban parks can be described in various ways depending on their purpose, components,

location and function (Nordh et al., 2009, 2011; Peschardt et al., 2012). In general, small urban parks can be considered a subset of urban parks. Thus, the function and components of these parks can be similar but may differ in terms of e.g. number of trees and shrubs, facilities provided, activities possible, etc. It seems logical to assume that small urban parks are different in use and appearance and have a different potential to provide ecosystem services as compared to larger parks. Small urban parks vary in size and shape ranging from 0.04 hectare to 2.4 hectares, according to various studies focusing on small urban parks (Forsyth & Musacchio, 2005; Nordh, et al., 2009; Ramirez & Zuria, 2011; Peschardt, et al., 2012). However, due to their small sizes, intensive use and pressures from surroundings are challenges towards sustaining the ecological quality and functionality of small urban parks. Although large urban parks can offer more in terms of ecosystem services, this does not mean that a large park is necessarily preferred to a small urban park. According to research, the primary functions of small urban parks can be categorised into three main aspects: (1) *Social*, (2) *Ecological* (3) *Human health and well-being*. As for *social* benefits, Peschardt, et al. (2012) found that small urban parks are primarily used for 'socialising' and 'rest and restitution'. Small urban parks also offer a positive sense of intimacy where people can communicate and interact with others in pleasant environment (Forsyth & Musacchio, 2005). Ample numbers of small urban parks provide opportunities for people to experience nature nearby their living areas. Parks situated in office and commercial areas provide a place for workers to relax, refresh and restore.

Konijnendijk et al. (2013) reported that, although research is still limited, there are some indicators that parks in general promote social inclusion and cohesion. As for *ecological* benefits, small urban parks can be seen as green stepping stones for species dispersal or recolonisation in the urban fabric. They thus function as a compliment to larger parks. Small urban parks to some extent fill the need for peoples every day contact with nature (Nordh & Østby, 2013). They can also help protect scattered rare species or small habitats, provide heterogeneity in the matrix, and habitat for an occasional small-patch-restricted species (Forman, 1995). Habitat-enlargement can be achieved through the allocation of different types or urban green patches in close proximity to each other (Colding, 2007). The ecological quality of urban parks is important for both humans and biodiversity because it fosters biodiversity and in turn enables people to have a stimulating contact with nature. A study in Flanders, Belgium illustrated how parks are importance to biodiversity (Werner, 2011). The investigated urban parks of Flanders encompass only about 0.03% of the area but accommodate about 29% of all wild plants and 48% of all breeding birds in the region.

Small urban parks maintain some level of species diversity and are important in keeping the metapopulation relatively stable and preventing localised extinction. A study by Ramirez & Zuria (2011) on the value of small urban greenspaces for birds in a Mexican city revealed that small green spaces in cities contribute to increase the total bird diversity in the city. Sometimes these areas include bird species that are not present in the remnant patches of native vegetation. Many studies have described the effects of urbanisation in terms of increasing or decreasing species richness, depending on several variables (McKinney, 2008; Pickett, et al., 2008; Reis, et al., 2012; Francis & Chadwick, 2013). Findings from the Baltimore Ecosystem Study (BES) in the US show that habitats in cities are more biotically diverse than commonly thought. Useful habitat consists not only of large green spaces but also of small pocket parks (Pickett, et al., 2008).

However, small urban parks are often too small to sustain a varied flora and fauna. Having said this, through the migration of organisms from larger core areas outside the city, the diversity in urban ecosystems can still be maintained (Bolund & Hunhammar, 1999). In the context of climate change, even small green spaces can have important effects on the urban climate and also be particularly helpful in improving air quality through the trapping of pollutants (Douglas, et al., 2011). According to Forsyth and Musacchio (2005), there are three main urban-air quality and climate problems that small urban parks can help solve: the urban heat island effect, local air pollution and potentially also global warming.

As touched upon above, it is clear that small urban parks contribute significantly to *human health and well-being*. There is sufficient evidence that urban parks promote public health indirectly, particularly through increased physical activity and obesity can probably be reduced by access to parks (Konijnendijk, et al., 2013). Nordh et al. (2009) also demonstrated that small urban parks have the ability to stimulate mental restoration. Time spent in nature appears to reduce stress and anxiety, and promote improved concentration. Small urban parks can serve as a place for contemplation, a retreat from the hustle and bustle of urban life.

In essence, small urban parks provide different (combinations or levels of) benefits than larger parks. As highlighted by Forman (1995), the optimum landscape state requires large patches (large parks), supplemented with small patches (small parks) scattered throughout the matrix and a landscape with only large patches of natural vegetation misses few values. Thus, even small urban parks are very important, but they are often overlooked. For example, the ecology of small parks has been less studied. There is a challenge in balancing between social and ecological benefits of small urban parks, as the ecological and social functions of the parks are closely interlinked. Increasing urbanisation and human population growth lead to increase in green space fragmentation, which reduces ecological quality because of reduced areal coverage and increased patch isolation. Human activities and the pressures of urban environments will alter the urban landscape (Zipperer & Guntenspergen, 2009), species population levels and persistence (McKinney, 2008), resulting in changes in plants and animal assemblages found. At the same time, humans also require small urban parks that are near, comfortable and pleasant to use

Resilience of urban green spaces

The Canadian ecologist C.S Holling introduced the resilience concept in ecology in 1973. Ecological resilience is defined as the amount of disturbance that a system can absorb before it changes state (Holling, 1996; Gunderson, 2000; Gunderson et al., 2002). Increasingly, researchers in urban planning and design have applied the resilience concept for better protecting urban green spaces, urban biodiversity and providing ecosystem services (Hunter, 2011; Niemela, et al., 2011; Francis & Chadwick, 2013). Resilience in ecological systems is the key to sustainable development and it should be part of the agenda for urban spatial planning and design (Colding, 2007). Resilience has been increasingly conceived as a perspective, as a way of thinking to analyse linked social-ecological systems (Brand & Jax, 2007), although ecological agendas have tended to dominate over social aspects. The concept of resilience offers a promising framework for analysing adaptive change towards sustainability because it provides a way for analysing how to maintain stability in the face of change. In order to take control of the vital links between human actions and environmental quality, people need to understand how cities work as ecological systems. Therefore, in determining the

biodiversity and ecological quality of urban green spaces, it is important to identify the site-specific factors. Access to green spaces is under threat within urban areas due to demand for space to construct housing, office building, roadways, and other structures. Remnants of natural and semi-natural landscape, parks, green spaces and other vegetation areas constitute the green skeleton and green infrastructure that contributes to the biological diversity of a city. The conservation and development of this infrastructure is an important challenge for urban planning (Werner, 2011).

According to Nordh & Østby (2013), small urban parks should be designed with natural components, shielded from disturbing surrounding and furnished with some seating to promote opportunities for restorative experiences and to function as social meeting places. In relation to the issue of disturbance, one can ask what disturbances occur in small urban parks. The term disturbances is often associated with resilience and has been applied in various ecological contexts. Disturbance is defined as a cause (which may be a system input) that results in a perturbation, which is an effect (or, change in system state) (Rykiel JR, 1985). Disturbances in urban ecosystems usually involve the destruction of biomass, such as the physical removal of an area of vegetation or soil, whether via natural or anthropogenic processes (Francis & Chadwick, 2013). In small urban parks, anthropogenic disturbances can be important drivers affecting the state of ecosystems. Anthropogenic factors (e.g. noise pollution, construction activity, traffic condition, wear and tear due to intensive recreational use, littering and misuse of resources) may represent the most intense and extensive form of disturbance. Examples of disturbances in urban park as described by Nordh & Østby (2013) are poor management, a lot of people and a noisy atmosphere. Anthropogenic factors can alter the behaviour, physiologies and morphologies of city-dwelling organisms (Grimm, et al., 2008). If human exploitation increases substantially, the ecological functionality of small urban park may reach an unstable state.

McKinney (2008) states that many studies on species richness in urban areas, and especially those focusing on smaller spatial scales, tend to note that species are eliminated via extreme human disturbances in the local vicinity. The effects of disturbances are different for different species. McKinney highlights a reviewed by Gaston et al. (1998) that found that in Britain, smaller areas are required to sustain viable population of plants relative to vertebrates because plants tend to have much smaller geographic ranges than mammals and birds. However, isolated small urban green spaces are typically visited by individuals of many of the same wideranging bird and mammal species. Animal species surviving in the urban environment are often opportunistic habitat and food generalists that can tolerate disturbance from and sometimes benefit from support by the public (Douglas, et al., 2011). Mahan & O'Connell (2005) found that species richness and diversity were lowest in parks containing manicured habitats and surrounded by human modified landscape. However, parks managed for passive recreation supported mammalian assemblages that was similar in richness and diversity to the riparian forest site. Meanwhile, Hogsden and Hutchinson (2004) found that butterfly species peaked at moderately disturbed sites compared with the least disturbed sites provided if the necessary resources are available. Their study also exhibits that the percentage of disturbance-adaptable species is lower than the disturbance-avoider species which indicated that environmental change are greatly affected by human disturbance in urban areas. Both studies supported the Intermediate Disturbance Hypothesis (IDH) that moderate levels of human disturbance promote the coexistence of many types of species diversity (Svensson et al., 2012; Francis & Chadwick, 2013).

Urban landscapes are particularly heterogeneous, as their complex and fragmented structure means that many different ecosystem or habitat types may be found in close proximity. In natural ecosystems, heterogeneity is often driven by disturbance and this can relate spatially to the disturbance heterogeneity model, which explains increased diversity due to dense mosaic of adjacent habitats that allows for rapid turnover of species and many species living within spatially limited area (Francis & Chadwick, 2013). The proximity of natural lands to human development facilitates access and opportunities for humans to disturb natural habitats (Sauvajot, et al., 1998). Brown (2008) presented a theory that describes the relationships between park size and distance from human habitation to park value diversity. According to Brown, urban parks and open spaces represent objects of desire that influence the distance/ diversity relationship but there may be instances where urban parks harbour undesirable community features (e.g., areas of drug trade, graffiti, litter) that can influence the park value distance/ diversity in unpredictable ways.

In examining the relationship between species diversity and resilience, Walker (1992) developed the analogy of 'driver' and 'passengers'. He proposed that functional groups of species can be divided into 'drivers', i.e. keystone species that control the future of an ecosystem, while 'passengers': species that live in but do not alter significantly the ecosystem. Walker proposed that the presence or absence of driver species will determine the stability of an ecosystem's ecological function. Meanwhile, Peterson, et al. (1998) suggested that the resilience of ecological processes depends upon the distribution of functional groups within and across scales. The combination of a diversity of ecological functions at specific scales and the replication of function across a diversity of scales produces resilient ecological function. In order to assess the total value of ecosystems in urban areas, it is important to add the value of all cells in the urban matrix (Bolund & Hunhammar, 1999). The individual values might be too small to maintain viable populations of species, but taken together the total value of urban ecosystems is potentially significant. In order to assess the ecology of small urban parks in terms of their resilience to disturbance, it is important to examine response diversity and functional diversity of the parks ecosystem. The combination of response diversity and functional diversity is generally seen as promoting resilience. Response diversity refers to the range of reactions to environmental change among species that contribute to the same ecosystem function (Elmqvist et al., 2003). Functional diversity refers to those components of biodiversity that influence how an ecosystem operates or functions (Tilman, 2001). Functional diversity influences ecosystem dynamics, stability, productivity, nutrient balance and other aspects of ecosystem functioning. Response diversity and functional diversity can be discussed for both human and non-human (plants, animals) phenomenon (Leslie and McCabe, 2013; Luck et al., 2013).

A political ecological view of small urban green space – balancing between ecological and social systems

In urban settings, decision for land allocation for urban parks, scenic riverways, community gardens or open spaces are influenced by ecological politics (Pincetl, 2007; Evans, 2007). Urban political ecology provides understanding on creation/recreation of nature to suit political, ecological, economic and cultural values (Pincetl, 2007). Evans (2007) explores how ecology and politics are woven into environmental governance in order to understand wildlife corridors as quasi-objects (entanglement of 'natural' and 'social' elements) that play a key role in articulating between the realms of ecology and planning. In another example Gandy (2002) explores the combination of political, economic and cultural developments that contributed toward the creation of Central Park in

Manhattan, New York by Frederick Law Olmsted. He traced how the park has emerged as a focal point for a myriad of debates and controversies in the field of urban planning. Olmsted's landscape vision, which combined political and aesthetic concerns in the creation of Central Park has contributed toward the advancement of democratic ideals and more refined conceptions of urban life. In the city of Berlin, Germany, issues of biodiversity protection have appeared on the political agendas since the 1970s. Lachmund (2013) uses the example of Berlin to describe how ecologists and naturalists created an ecological understanding of urban space on which later nature-conservation policy was based. Urban planning has been complemented by a systematic policy of 'biotope protection' for the Species Protection Programme. Lachmund's study shows the mutual formation of science, politics and nature in an urban context, implying e.g. that ecological aspects cannot be seen separately from their social and political context.

Governance and management of urban green space and the ecosystem services they provide faces several challenges. Management of small urban parks can influence the diversity and complexity of the park's ecology because their small size limits the number of wildlife species to generalist and edge species (Francis & Chadwick, 2013), but management for these species can provide more suitable habitat. This has been discussed by Ernstson, et al. (2010) concerning scale mismatches in governing urban green spaces in Stockholm. Management of urban green space in Stockholm is most frequently organised by the municipalities. However, these municipalities classified local green area such as allotment gardens, golf courses, and private home gardens as 'developed land' and did not always recognise as the role of green areas in sustaining landscape ecological processes. This situation created scale mismatches because the municipalities ignored the role of local green areas in sustaining species diversity in higher level governance processes.

Managing small and other urban green spaces requires a comprehensive framework and guidelines. In Malaysia, every municipality has a guideline for urban greening. For example, Petaling Jaya City Council (PJCC) has a vision to recreate nature in the city to provide a comfortable, healthy and quality living environment. Their target is to have more than 500,000 trees in the city, which means at least one tree per resident. Currently, Petaling Jaya has a total of 355 hectare of open space with 150,000 trees. The council also wants to create wildlife habitat in the city to improve the urban ecosystem. In line with this, retention ponds under its care have been enhanced with more greenery to attract wildlife and for recreational purposes. However due to the irresponsible attitude of some people, the lake water has been polluted and needs to be cleaned, which is costly. There was a case in 2009 whereby three tonnes of dead fish was found in Kelana Jaya lake. The council couldn't identify the source of pollution as the lake is connected to the drainage system. Apart from that, the activities of park visitor also influence the lake condition. It is common to have people bringing their fishing equipment to the lake, netting some big fish resulted in disturbing the lake bed and churning up plant matter which causes turbidity

Urban parks are not only viewed as spaces where a spectrum of recreational and leisure activities can be pursued, from active to passive, but they are also seen as places that by design or happenstance can provide us with unique natural environment. Thus, one of greatest challenges to urban park planners, landscape architects, and managers is to balance the tension between providing for the diverse uses and values of parks space, preserving and enhancing the unique qualities of environment. Urban ecology as an integrated science has emerged in understanding primarily the biological and physical features, as well as biochemical cycles, of urban parks.

In the application of ecological resilience concept to urban parks, *human-related* activities are often seen as disturbances, which conflicts with the purpose of designing and managing parks primarily for people to recreate and enjoy nature in urban settings. How can this conflict between ecological and social systems and interests be dealt? Both social and ecological aspects in urban parks are important, and there are many examples of a high quality of urban nature also increasing the quality of the area for urban citizens, while also directly affecting the behaviour of people in using parks. Through strategic environmental education and public awareness raising on the importance of biodiversity and species richness in urban parks, people can be made aware of their positive and negative roles in shaping the environment and its impact on other species. Thus there is a need for a more comprehensive framework for identifying, enhancing, managing and monitoring of small urban parks. This framework should e.g. explore potential biodiversity and species richness in each urban green space, but also link this to social demands, people's perceptions, and learning.

Application of a social-ecological approach to small urban parks

It is increasingly important to design, establish and manage small urban parks that can serve as a place for people to rest and restore, socialise and experience nature. The integration of landscape ecological research with social science, combining these as a base for landscape architectural, planning and management practice provides a rich opportunity for understanding the implications of future landscape change. With an appropriate design and adequate management practices, even for small green spaces the negative consequences of intensive urban development can be reduced, even in industrialising countries where most of future population growth will occur. Assessing and enhancing the resilience of small urban park ecosystems requires understanding of how interactions between human and ecological processes affect the resilience of inherently unstable equilibrium points between the natural attractor and the sprawl attractor. Small urban parks must be designed for ecological, biological and socio-cultural diversity. The social-ecological system approach offers potential in improving linkages of cultural and biological diversity in urban settings (Berkes, et al., 2003; Colding & Barthel, 2013). Thus, by adapting a social-ecological system approach, it can lead to a more thorough understanding of human-environment interactions, and the conflicts between human and nature could be consider, assess and manage (Ban, et al., 2013). In management of urban green spaces, more efforts needs to be put into monitoring, evaluation and developing models of both the social and ecological dimensions.

Urban green spaces represent arenas for management and development of interlinked biocultural diversity, environmental and ecological learning, and learning related to social organisation, the politics of urban space, social intreprenurship, as well as positive place making, community empowerment, restorative environments, and fostering of democratic values (Colding & Barthel, 2013). The role of cultural diversity in maintaining resilience has not yet clearly defined, but it seem established now that there are important links between cultural diversity that impacts e.g. perceptions, use, design and management of urban green spaces and variation in green space character, habitats and species composition (Berkes, et al., 2003; Colding & Barthel, 2013). There are many example of adaptation of a social-ecological approach in designing, managing and monitoring of urban green spaces. Hunter (2011) promotes 'designed experiments' wherein designers create a product that balances ecological, aesthetic, and urban functional goals to guide urban planting design. She claimes that this is an ideal approach for evaluating the ability of the adaptation strategy to support resilience of ecosystems impacted by climate change. Forsyth and

Musacchio (2005) promote an ecologically-based management approach for small urban parks. The size of small parks may result in intensive use by people and requires intensive (and expensive) maintenance. Therefore, turning some of the parks in a wilder state with lower maintenance planting designs should be considered. The selection of plants appropriate to the site conditions and careful planting are very important in terms of long-term survival. When establishing plants in urban parks, it is crucial to create a good growing environment. In another study, Lundberg et al., (2008) suggested the *mobile link* concept towards prevention of ecosystem degradation and biodiversity loss in increasingly fragmented landscapes. Their study on the Eurasian Jay bird (*Garrulus glandarius*), a mobile link species that importance for the oak regeneration in an urban landscape indicated that the continuous seed-dispersal by the bird will ensure the availability of the oak tree in future. A mobile link species provides and supports essential ecosystem processes by connecting patches and linking the disturbed site to undisturbed source areas. The mobile link concept can also help link between different scale levels of management, uniting managers around a common goal and thus act as a catalyst for improved regional management. At city scale, the concept of green infrastructure has been widely used to upgrade urban green space into coherent and integrative urban planning. Green infrastructure can comprise of all natural, semi-natural and multifunctional ecological systems at all spatial scales. The green infrastructure framework uses an integrated approach to landscape management and development, assessing the value of investment through a combined ecological, social and economic approach. Thus, it explicitly links social and ecological systems.

Conclusions

In achieving urban sustainability, the resilience approach will allow urban planners, designers and decision-makers to learn and adapt to the inevitable failures of urban management actions, as well as to improve the integration of ecology, urban planning and design. It offers a foundation for collaborative work between designers and ecologist to expand the understanding of urban ecosystem processes and performance. The approach is also valuable for managing small urban parks, in terms of enhancing their ability to absorb and respond to disturbances. Small urban parks can make important contributions to urban biodiversity and to a range of ecosystem services. The value of biodiversity for people living in urban area has become more widely appreciated. Small urban parks do not only provide settings for restoration, but also for social and physical health (Nordh & Østby, 2013). Therefore is it important to evaluate the ecological potential and constraints of these parks in order to support planning and urban nature conservation. It is important to recognise the specific role and importance of small urban parks, e.g. within a green infrastructure approach. Moreover, a socio-ecological approach to small urban parks and to the conceptualisation and implementation of the resilience approach will ensure the required linking of ecological, social and cultural aspects.

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