Urban green spaces in transition: Urban social-ecological resilience in the region Frankfurt Rhine-Main—A review

Pinar Bilgic[1]

[1]*Technical University of Darmstadt, pinar.bilgic@stadt.tu-darmstadt.de*

Abstract: This study reviews the fundamental literature and emphasizes the significance of urban green spaces (UGSs) of the studied case, the Frankfurt Rhine-Main region (FRM). UGSs as natural resources provide benefits against main climate-related urban hazards—floods, droughts, and heat waves—and are considered as essential components of climate adaptation. Also, UGSs are spatial resources for densification, a key instrument against sprawl. UGSs' competing functions cause urban land-use conflict in many growing metropolitan regions. FRM, with its increased frequency, randomness, and severity of climate hazards and peaking rates of housing demand, is no exception to this trend. In this study, the literature review is guided by a conceptual framework which assigns urban land-use competition as the point of departure and the concepts of regional economic development and environmental protection as entry points to urban social-ecological resilience. Although resilience, as a theory of social-ecological system property, is already studied extensively, it still needs to be unpacked to be operationalized in planning practice. This work looks at the links among theory, policy, and practice and suggests that resilience is most purposeful when it is approached rather as an integral process to planning and management than an end destination. (195 words)

Keywords: urban green spaces; urban social-ecological resilience; urban transformations; Frankfurt Rhine-Main

Introduction

Background

This study emphasizes the significance of urban green spaces (UGSs) in urban planning practice and looks at their contribution to urban social-ecological resilience in the context of the Frankfurt Rhine-Main (FRM) region in Germany. In the face of ongoing urban transformations triggered by the peak housing demand, ensuring sustainable urban growth in planning practice is a major concern. Improving and sustaining the benefits UGSs provide, especially during times of inevitable urban transformations and a changing climate, is essential.

Since the preindustrial times, FRM has been a region of high economic activity. Today, after its industrialized and de-industrialized phases, the region is still home to production, commerce, and high international financial activity, administration, and services. The region performed relatively stable during the global financial crisis of 2008-2009, and a reason for this has been the diversity economic

activities and socio-demographic composition. As this diversity and stability is attracting an unprecedented rate of domestic (mainly due to shrinking and declining cities in some German and European regions) and international migration (mainly due to refugee situation since 2015 and Brexit, as the city of Frankfurt is assumed to carry further some financial functions of London in continental Europe), activating spaces to provide housing requires immediate responses from national and subnational levels of administration. Recent prognoses showed that additional regional housing supply until 2030 should number approximately 184.000 dwellings (Regionalverband FrankfurtRheinMain, 2016). According to a recent analysis, the region can actually provide 220.000 new housing units through densification (106.000 units), through new development on open land (100.000 units), and through promoting mixed-use in available industrial and commercial zones (14.000 units) (*ibid*). A great majority of this potential (183.000 units) is located at the areas with well-connected public transportation facilities. The motivation behind providing more housing at the areas with well-connected public transport is to directly contribute to less car dependency (Figure 1).

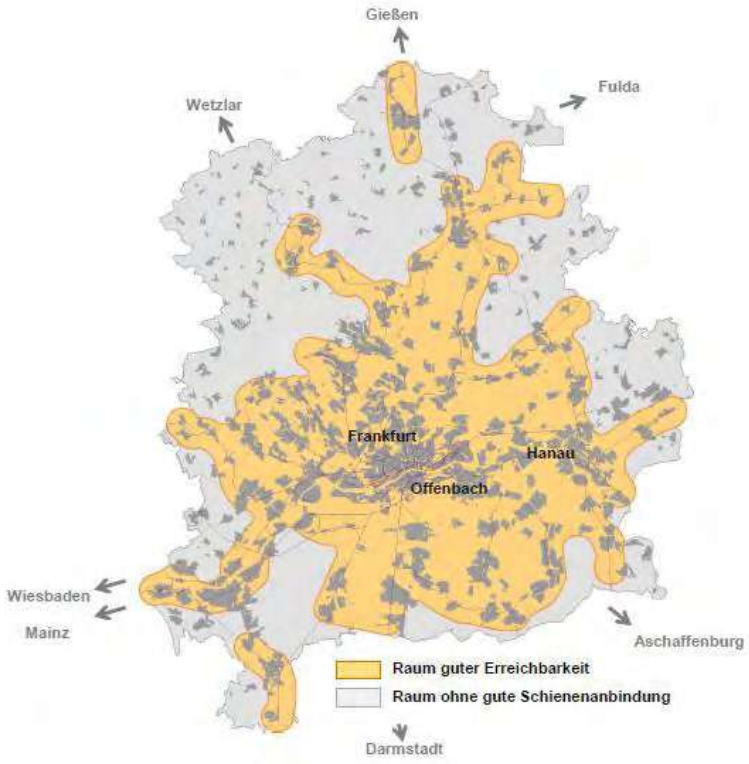

Figure 1: The area of well-connected public transportation with a housing provision potential of 183.000 dwellings (yellow) mostly through densification (source: Regionalverband FrankfurtRheinMain, 2016).

Problematization

Due to the accelerated rates of housing demand in regions with high economic activity, urban growth should be spatially controlled and managed to avoid sprawling over natural landscapes and urban densification is a strategy often employed in achieving this. At the same time, the impacts of increased frequency, randomness, and severity of main urban hazards—namely flood, drought, and heat wave—on human wellbeing become more severe, as urban densification might take place at the expense of UGSs.

In this regard, UGSs can fulfill two mutually incompatible roles: as natural resources for climate adaptation and as spatial reserves for urban growth. These competing functions of space bring about a major challenge in urban land-use planning and management in many growing metropolitan regions in the world. The FRM region, with its peaking rates of housing demand and increased damage of urban climate hazards, is no exception.

Purpose of this study

The aim of this work is to discuss and reflect on the results of an extensive literature review. The texts with the greatest potential to inform the concept, content, and context are reviewed. The most relevant previous work is identified and input from key scholarly body is brought together. The reviewed body of literature is compiled, thematically grouped, and critically reviewed between December 2018 and March 2019. The relevant literature body is found out by systematic searches in major scientific databases (Web of Knowledge, Scopus, Google Scholar) and the University and State Library of Darmstadt University of Technology. Following keywords are used with various combinations: urban green spaces; land-use conflict; urban densification; urban sprawl; regional economic growth; environmental protection; climate adaptation; resilience; social-ecological systems (SESs). Initial output is narrowed down by a category (architecture, urban planning, urban development, urban studies, landscape ecology) and document type filter (articles, books, book sections, proceedings, policy documents). Among these, 55 documents inform this study. The workflow to carry out the literature review has been as follows: 1. defining review questions based on the research problem (i.e. urban land-use competition); and 2. selection and review of relevant key literature. The below conceptual framework guides the review:

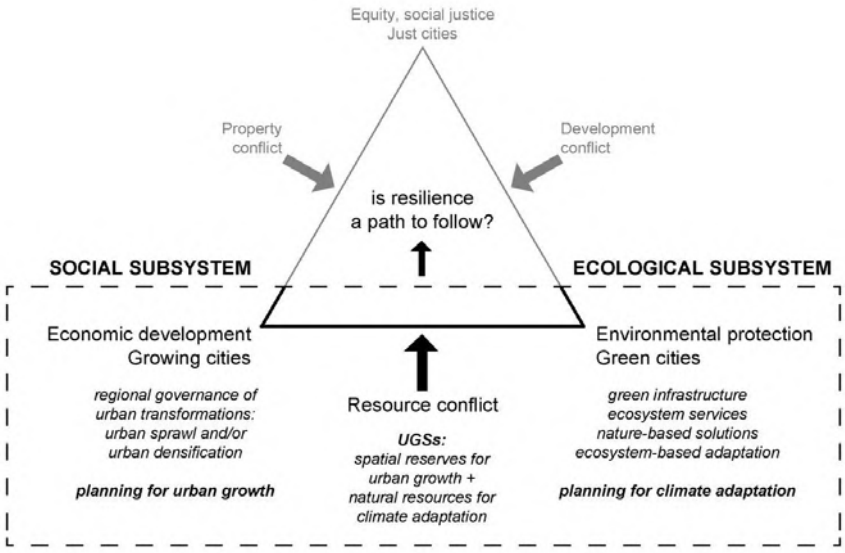

Figure 2: Conceptual framework: a model of priorities, relationships, and conflicts associated with the components of SESs (source: adapted from Campbell, 1996).

Resource conflict

Land as a scarce resource

Urban areas are where most of the global population and economic activity is concentrated. As hubs of knowledge and innovation, they are the engines of national economic growth. As dynamic systems

being constantly exposed to both abrupt and steady change, today's urban areas face massive social, economic and environmental challenges which calls for a restructuring in conventional planning and management to adequately address human wellbeing.

The aftermath of Second World War marks the beginning of an era in which human activities have started to alter the environment more extensively and rapidly than any other time in human history, with increasingly devastating environmental impacts (Grimm *et al*., 2008). Although cities are not covering more than around 3 per cent of Earth's overall land surface, these devastating global impacts are attributed to cities (Alberti *et al*., 2003; Grimm *et al*., 2008; Gago *et al*., 2013). Growing evidence shows that the functioning of urban systems is dependent on the environmental benefits provided by UGSs. How urban growth takes place influences the quality and quantity of UGSs and their benefits to a great extent: *growing in* (urban densification) might tend to take place at the expense of green spaces *within* an urban area; whereas *growing out* (urban sprawl) might tend to cause a significant loss of green spaces *around* an urban area. Furthermore, it cannot be ignored that both economic and ecologic systems need an interconnected critical mass of land to be sustainable, and that "the continuity of one system invariably fragments continuity of the other" (Campbell, 1996, p. 20)

Arguably one of the most comprehensive works produced in reframing the conflicts and tensions inherent in planning discipline is Campbell's "Green cities, growing cities, just cities? Urban planning and the contradictions of sustainable development" (1996). This article invites to rethink what sustainability is and to acknowledge the inevitable conflicts in planning discipline so that we no longer romanticize our sustainable past, as this attitude seems to be misleading in addressing contemporary problems. In preindustrial times communities had no alternative but be sustainable, because the feedback mechanisms were too short-term: if our ancestors destroyed vegetation, they would die out. Today, the scope of our alterations on nature is so massive that we do not necessarily suffer the consequences of these alterations (*ibid*). As Neuman (2005) also agrees, urban models from old, preindustrial European and North American cities keep inspiring us as sustainable models of urban form, however, today's complexities require thinking beyond that.

Campbell (1996) describes the resource conflict, the conflict between economic growth and environmental protection priorities as the '*Ur-Konflikt*' (p. 6). Resource conflict is mostly evident in urban land-use, as it is nearly always a tradeoff between social, economic, and environmental goals, a result of decisions that are irreversible, long-term commitments (European Environment Agency (EEA), 2015). Because of this, drivers and consequences of, and control for land-use is always a societal matter: land-use decisions shape the built environment and determine where and how economic activity takes place, where communities develop, and how natural and built environment is configured and reconfigured (Goetz *et al*., 2004).

Studies aimed at classifying and qualitatively assessing the state of understanding on global trends in land-use found out that urbanization is one of the major drivers of massive change (Lambin *et al*., 2001; Alberti *et al*., 2003). It is also observed that massive changes in land-use and land-cover often overlap with new practices motivated by regional incorporation into a world economy. Triggered by globalization, transformation of urban-rural linkages at regional scales is taking place quite intensely and, consequently, ecological footprints of a city-region in the developed world might expand over several hundred times of the actual surface it covers (Grimm *et al*., 2008; Gago *et al*., 2013).

Compact versus sprawl

Based on above discussions on globally driven urbanization and its consequences on land-use and land-cover change, this subsection focuses on a particular spatial form of urban land-use competition: compact versus sprawl. This is of crucial relevance to UGSs, because what remains as inner-city green spaces after implementation of urban densification strategies can tell much about the extent of densification practices.

In Europe, urban development in the form of sprawl first appeared after the Second World War. In parallel to economic and population growth, planning and management of urban growth promoted a spatially expansive model and resulted in the formation of large peripheral extensions to existing urban settings. These extensions were not limited to provision of new housing as more expansion required more social and technical infrastructure, which eventually triggered progressively more sprawl (Olofsdotter *et al*., 2012). Today, this spatial configuration has important costs as it fragments landscapes, degrades water quality, demands a great deal of provision and upkeeping of social and technical infrastructure (Alberti *et al*., 2003).

Sprawl indicates an urban form that is to be avoided and connotes not only a massive loss of natural environment but also an increase in car dependency, greenhouse gas emissions, air pollution, high infrastructure investment, operation, and maintenance costs, and social segregation. Today, sprawl is found out to be the most dominant form of urban transformation as several studies have found out that even some shrinking European cities are sprawling, and it cannot be claimed anymore that population or economic decline and spatial shrinkage are directly tied (EEA, 2006; Kabisch & Haase, 2012).

Based on this, compact urban form with higher density receives recognition as a key remedy against urban sprawl (Olofsdotter *et al*., 2012; Davern *et al*., 2017). The ideal of compact urban form is however not unproblematic (Olofsdotter *et al*., 2012). Although the compact city approach as a key response to urban sprawl has benefits such as limiting ineffective land-use and subsequent problems, provision and conservation of UGSs during densification is a major challenge in planning practice (Dallimer *et al*., 2011; Haaland & van den Bosch, 2015). Urban densification is associated with increased impervious surfaces and decreased vegetation cover. It is also necessary to highlight that the parking spaces for the additional housing provided by densification is a great contributor to the increase in impervious percentage. This, in turn, is one of the main drivers of the urban heat island effect and increased risk of water-related hazards (Grimm *et al*., 2008) and, therefore, requires alternative ways of densifying urban areas, through implementations such as adding floors on existing buildings and using underutilized parking spaces for new construction.

Moving beyond urban form

The root causes of the resource conflict are not always only spatial, and it could not simply be eliminated by just a ‘spatial fix’ (Campbell, 1996, p. 13). Similarly, Neuman (2005) argues “one cannot overlook the fact that form is both the structure that shapes process and the structure that emerges from a process. Yet the question that should be asked is whether the process of building cities and the processes of living, consuming, and producing in cities are sustainable” (p. 22).

A unifying concept: Rethinking resilience thinking

The aforementioned urban land-use competition in general and the conflicting views on compact and sprawled urban form in particular can be framed under the resilience concept, because the regional economic development end of the tension aligns with the social subsystem and the environmental protection end of the tension aligns with the ecological subsystem of the SES thinking.

The existing resilience literature covers various disciplines, has different starting points and different definitions and a fragmented structure (Chelleri, 2012). In this study, normative assumptions and prescriptions of how to become resilient are of little importance. The discussions rather revolve around the components of what makes resilience thinking a rich concept that is capable of informing today's highly complex challenges in urban planning. Therefore, it is acknowledged that cities are complex, adaptive systems of constant steady and abrupt change ongoing with a degree of uncertainty and UGSs are approached as SESs by unpacking SES thinking that is actually embedded in planning discipline.

As the aim is to operationalize the resilience concept in urban planning, it is necessary to briefly revisit some key definitions in the evolution of the concept and how it made its way to planning. At an earlier stage, engineering resilience is defined as "the ability of a system to return to an equilibrium state after a temporary disturbance" (Holling, 1973, p. 14). This definition emphasizes the capacity to *bounce back*, to return to original state and being fail-safe. To *bounce back* is however not always favorable. There are cases that it is better for a system not to return back to previous equilibrium or stable state, as it might actually mean returning back to status quo which caused the system's current problems at the first place (Eraydin, 2012). Holling (1996) then defines ecological resilience as "the magnitude of the disturbance that can be absorbed before the system changes its structure" (p. 33). Here, the emphasis is rather on the capacity to *bounce forward*, the amount of disturbance a system can take before reaching a new stable state.

What is common in both descriptions is the assumption that there is an equilibrium state to return back or to reach to. However, such an ideal of equilibrium is "too mechanical to reach" in planning discipline and can be misleading (Davoudi *et al*., 2012). Instead, evolutionary, *i.e.* social-ecological, resilience is described as the ability of complex SESs to change, adapt, and transform while undergoing change (Folke *et al*., 2010). This approach is promising in planning discipline as it acknowledges not only fast and abrupt (*e.g.* disasters) but also slow and cumulative (*e.g.* hazards) changes which might also bring extreme outcomes (Davoudi *et al*., 2012).

SES thinking is as central to planning as it is to resilience. As cities are being acknowledged as human-dominated ecosystems, this approach brings together otherwise separated domains of natural and social sciences in explaining how the interactions between humans and ecological processes create cities (Alberti *et al*., 2003). Resilience Alliance (2010) defines SESs as "an integrated system of ecosystems and human societies with reciprocal feedbacks and interdependence" (p. 52). Human-nature interactions are closely coupled in cities (du Plessis, 2008) because "cities are SESs and should be studied as such" (Grove *et al*., 2015).

This is particularly important as resilience is, broadly speaking, the study of what systems do while undergoing change (*e.g.* in this study: change that is reflected in form (land cover) and function (land-

use). To ignore or to resist to change has costly consequences: it creates a vulnerable condition for the system, as it foregoes emerging opportunities and limits its options (Walker & Salt, 2006). Still, a thorough understanding of today's societal and environmental change is no simple task to tackle. Today, as we are transitioning from "known extremes to unknown extremes" (Coaffee & Lee, 2016, p. 135), regardless of how well we study and learn from past patterns, the new patterns of change tend to unfold in unexpected ways. Resilience thinking, as it emphasizes humans-in-nature perspective, integrates SES thinking in urban studies, and embraces system attributes such as complexity, adaptability, and uncertainty, is a positive vision of human wellbeing as for it proposes tools to understand change (Pizzo, 2015).

Social subsystem: Housing must be provided

In order to analyze the drivers and consequences of regional economic growth and what it entails within the social subsystem, some phenomena and trends must be well-understood. Perhaps one of the most discussed trends in the scholarly literature is the impact of globalization and global networks on emergence and functioning of urban regions, as today's cities are competing and cooperating to belong to a socioeconomic network that operates at a global scale (Alberti, 2003). Supranational governmental and corporate institutions have enabled the rise of global city networks and this influences the urban processes to a great extent (Neuman & Hull, 2009). Within the inter- and transnational hierarchy and ranking and the complex global network, internationalization of resource flows has the power to shape contemporary cities (Sassen, 2005), their forms and processes.

In the midst of the global pressures, it is of critical importance how scarce land resources are used: is the benefit of society as a whole a central concern in terms of economic prosperity and quality of life? (Goetz *et al*., 2004). As previously discussed, population growth is a predictable outcome of regional economic development, which in most cases requires immediate responses from public and private actors to activate spaces to accommodate the growing population. Accustomed technical planning options are to grow inwards through densification, grow outwards through sprawl, grow upwards through high-rise, and various combinations of these. Whichever path is followed has strong societal, environmental, and economic implications (*ibid*). It is therefore necessary to understand how these processes are planned and managed.

Based on this, regional governance appears as an important field of investigation within the social subsystem. Regional governance can be defined as the interaction among public and private actors in an institutional context with a normative basis to address and solve societal problems. It either builds bridges and has a supportive nature, or it builds barriers and has a restrictive nature (Bressers & Bressers, 2016). Complementarily, Resilience Alliance (2010) defines governance as "the interactions of diverse public and private actors, their sometimes conflicting objectives, and the instruments chosen to steer social and environmental processes within a particular policy area" (p. 51) emphasizing the fact that different actors will potentially bring different and conflicting objectives, and this, too, is a part of governance.

An important attribute of governance in the context of resilience and SESs is its adaptability. Adaptive governance is defined as "institutional and political frameworks designed to adapt to changing relationships between society and ecosystems in ways that sustain ecosystem services" (*ibid*, p. 51). It promotes interactions across levels and scales of conventional administration, including

interactions between formal (laws, constitutions, rights, etc.) and informal (social and behavioral norms of society) institutions of a governance system. Adaptive governance emphasizes the capacity to adapt to changing interactions between social and ecological subsystem in a way that it sustains its functions and services. When adopted, adaptive governance can be a switch from rigid to flexible, exclusive to inclusive, uniform to diverse, and conventional to innovative.

Ecological subsystem: Environment must be protected

Although regional economic growth priorities tend to exploit the nature simply to sustain growth, environmental protection is also a major goal in planning research and practice, because growth is dependent on the environment. Therefore, the ways to ensure that this dependence is a healthy dependence instead of a parasitic one should be understood. There is growing recognition that the natural environment provides tremendous benefits to human wellbeing, and that urban areas can only function depending on these benefits. The benefits of UGSs—as crucial contributors to adapting the local outcomes of a changing climate—cannot be separated from some key concepts that landscape ecology introduces to urban planning. Of course, applying ecological knowledge to cities is nothing new, though a revolutionary approach has been to investigate the 'ecology *of* cities' rather than the 'ecology *in* cities' (Grove *et al*., 2015), which has found the separation of the natural and unnatural in a city rather artificial, and observed the city as a whole.

The increase in the frequency, randomness, and intensity of the three primary climate-related urban hazards, namely floods, droughts, heat waves (Depietri *et al*., 2012; EEA, 2012; Chen *et al*., 2016), is coupled with and aggravated by urbanization. In Europe, flooding is the most important hazard in terms of economic loss (EEA, 2010). UGSs have a big capacity to absorb excess, runoff water, unless their quality is not reduced by poor land-use practices (Depietri *et al*., 2012). Even small patches of vegetation cover in urban areas, such as pocket parks, are contributing to the natural hydrological cycles (Grimm *et al*., 2008; Green *et al*., 2016) and decreasing the pressure on the aging and mostly centralized water infrastructure in post-industrial cities of Europe (Green *et al*., 2016). Drought, on the other hand, is not directly visible in urban areas as flood is (Bressers & Bressers, 2016), but it has dramatic interruptive and costly consequences such as the damages in agricultural supply. This imbalance between too much water and too little water is damaging economies. UGSs are an important component of water-sensitive urban planning and design especially because their contribution to closing water cycles, vegetation cover is to be protected and provided in contribution to harvesting and reuse of water to tackle drought (EEA, 2010).

Heat waves are associated with long-term high temperatures with notable impacts on human mortality, regional economies and ecosystems, and have been the most important hazard in terms of fatalities (EEA, 2010). As a local impact, urban heat island (UHI) phenomenon has also been studied quite extensively. Due to UHI urban areas tend to have higher temperatures compared to their rural surroundings, especially at night (Grimm *et al*., 2008). Its magnitude at a local scale far exceeds its impacts on global climate (*ibid*). Based on their quality and size, the cooling effect of UGSs can reach up to 50 to 100 meters offset in the built environment. It is therefore important to involve protecting and providing green in response to heat waves and UHI effect.

These are some major outcomes of a changing climate that has local impacts and can be addressed locally through integration of adaptation measures into planning. Adaptation is defined as "the ability

of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (IPCC, 2007). Adapting to the outcomes of climate change does not entail that negative impacts are to be eliminated through climate-proofing, rather it addresses reducing the severity of these impacts in a way that is not solely physical, but also political, institutional, and even behavioral. At its core, adaptation differs from mitigation measures, which has a supranational motivation to slow down the pace of climate change. Although UGSs have benefits in climate change mitigation efforts, as well, the scope of this study is deliberately limited to the local scale and it focuses on benefits of UGSs in local climate change adaptation.

Grove *et al*. (2015) propose four main propositions to be integrated when studying at the intersection of urban studies and ecology: 1. The ecology in and of cities looks at the entire metropolitan land-use and land cover system, not just the rural green. 2. It embraces the spatiotemporal and scalar complexity of urban mosaic. 3. It integrates knowledge from the social and ecological sciences and highlights the need to integrate diverse disciplines within the abovementioned layers of complexity. 4. The overarching aim is to be useful both for decision-making and science (p. 2, 7, 9). In order to make full use of and derive benefits from UGSs in adapting the impacts of local climate change hazards, it will be necessary to borrow some key concepts from landscape ecology (green infrastructure, ecosystem services, nature-based solutions, ecosystem-based adaptation) (Figure 3) and integrate them to theories and practices of urban planning. As these four concepts are gaining prominence both in theory and policy, it is therefore necessary to have a clear understanding of what they entail.

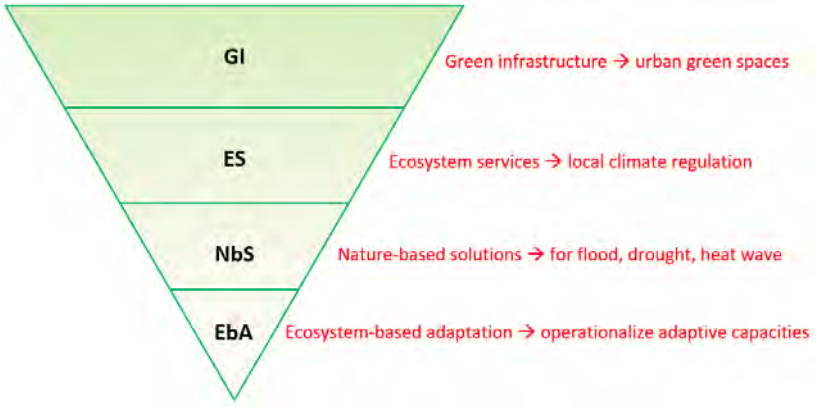

Figure 3: Four key concepts of landscape ecology in urban planning (source: author).

Green infrastructure is "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations" (Benedict & McMahon, 2002, p. 7). Similar to any other infrastructure, major physical components of green infrastructure are its nodes (*e.g.* parks, gardens) and connections (*i.e.* green corridors). Connectivity is an essential quality and characteristic, because it enables the green network to function as an ecological whole (*ibid*; EEA, 2004). The 'infrastructure' approach to UGSs is actually more than just a metaphor, since in planning discipline it is planned and managed as such.

Ecosystem services is defined as the benefits people obtain from ecosystems (Millennium Ecosystem Assessment (MEA), 2005). Costanza *et al*. (1997) listed 17 ecosystem services from gas regulation to

cultural; MEA (2005) further developed these categories as provisioning services; regulating services (including local climate regulation); cultural services; and supporting services. Due to the abstract nature of the concept, grouping and regrouping ecosystem services have not eased the difficulties in practical use of ecosystem services (Niemelä *et al*., 2010), particularly in planning.

Nature-based solutions are defined as the "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" and approach ecosystem services as resource-efficient and adaptable responses to societal challenges (Cohen-Shacham *et al*., 2016, p. xii). These societal challenges entail water and food security, human health, disaster risk reduction, and climate change (*ibid*). Nature-based solutions is a relatively newer concept which can be quite helpful in translating the knowledge of ecosystem services to urban planning. According to Faivre *et al*. (2017), nature-based solutions have the capacity to turn ecosystem services into innovative responses to "optimize the synergies between nature, society and the economy" (p. 509).

Ecosystem-based adaptation is a subset of nature-based solutions (Pauleit *et al*., 2017) and defined as "the use of biodiversity and ecosystem services to help people adapt to the adverse effects of climate change as part of an overall adaptation strategy" (Convention on Biological Diversity, 2009, p. 9). Another definition by Munang *et al*. (2013) is as follows: "fundamentally, ecosystem-based adaptation is the use of natural capital by people to adapt to climate change impacts, which can also have multiple co-benefits for mitigation, protection of livelihoods and poverty alleviation" (p. 67). The concepts nature-based solutions and ecosystem-based adaptation are implementation-oriented and, therefore, frequently utilized policy arena. This is promising in terms of benefitting from the richness of the ecosystem services concept, which has so far mostly studied in the scientific literature. Moreover, the intersection of urban studies and ecology is rather concerned with the identification of root causes of SES change as a whole, than to figure out a 'quick fix.'

Theory-policy and policy-practice interface

Up until this point, this study has been a summary of an extensive critical review of the major scientific literature, guided by the concepts urban land-use conflict, social-ecological resilience, regional economic growth, and environmental protection, with limited reference to context-specific implications. Given the importance of operationalization of theoretical knowledge in practical knowledge in the field of urban planning, it is necessary to integrate the main findings from the key policy literature to understand the transition (*i.e.* social and ecological change) in the specific contexts of international (mainly Europe), national (Germany), and subnational levels of administration.

International level: Among the concepts which constitute the conceptual framework of this study, the resilience concept is quite frequently forming the basis of many international policy documents created by international organizations such as the World Bank, OECD, ICLEI. There seems to be a tendency that these policies are aiming at 'making cities resilient,' referring to resilience as a quality that is with no exception preferable, a state of being that is to be achieved. Another tendency is that the resilience concept is employed often in the context of disasters, though it can still be a key policy element in response to transitions through which slow, gradual change has great impacts on urban systems.

European level: Europe is a small but a very densely populated continent. More than a quarter of its land is affected by urban land-use, around 80 per cent of its population is living in these areas (EEA, 2006). Though urban sprawl in the Anglo-Saxon literature is mostly observed as a challenge that is specific to north American and Australian cities, sprawl poses great challenges for European cities, too (*ibid*). Because of this, European-level policies are inclined to promote compact city ideal in parallel to green growth strategies. Having the majority of its member states located in Europe, a similar tendency can be observed in OECD's policies, as well (OECD, 2011).

National level: Federal-level planning principles in Germany prioritize strategies against sprawl, *e.g.* reducing daily open land consumption from 113 hectares to 30 hectares by 2020 (*30-ha-Ziel*) and by protecting natural environment through "inner before outer development" (The Federal Government, 2002). Although this ambitious goal will probably not be reached (NABU (2017) pointed out that in year 2017 daily land consumption was still around 66 hectares per day), this strategy urges sub-national governments to protect natural environment and to adjust urban growth strategies accordingly. Since this strategy gives a clear vision and a direction, it is arguably a practice-oriented goal towards an optimal land-use. As a response, from 2006 onwards, the dual inner development policy started to appear in policy literature. According to dual inner development strategy, spatial reserves in an urban area should be utilized in favor of urban densification, while at the same time green space qualities (proximity, accessibility, connectivity, etc.) are secured (Böhm *et al*., 2016). However, the question of whether an increase in urban green space quality can offset the decrease in urban green space quantity requires more investigation (Haaland & van den Bosch, 2015).

Subnational level: This level of administration is divided into two sublevels in itself (federal states, *e.g.* Hesse, and their governmental districts, *e.g.* South Hesse) and of strategic importance as it provides data for federal-level policymaking and also for local-level implementation. For instance, regional land-use planning falls under the responsibilities of the governmental district of South Hesse, to be prepared in cooperation with the towns and municipalities.

Municipal level: Local administrations in Germany have full authority and responsibility within their administrative boundaries. As in the example of FRM region, some municipalities in metropolitan regions are members of regional authorities. The Regional Authority FRM with its 75 member municipalities including the city of Frankfurt, is the governance body of the metropolitan region, in charge of creating regional-scale concepts to address current regional challenges through enabling vertical and horizontal dialogue and bridging federal and subnational levels of administration. For instance, Regional Authority's task for the urban land-use competition has been to develop a strategic plan for its member municipalities that addresses regional (economic) growth on one hand and environmental protection on the other. In cooperation with the governmental district of South Hesse, the Regional Authority provides its municipalities with information and guidance in implementing social and ecological measures. It is also important to note that, as Keil (2011) argues, the FRM region has had continuous economic growth while undergoing massive industrial restructuring, which urges for a restructuring in its governance mechanisms.

Conclusions

What this study amounts to is that by critically reviewing a multidisciplinary body of literature it emphasizes the significance of UGSs in urban planning practice. To understand the context of the

studied case, the FRM region, the findings from key policies are also integrated. The point of departure is a major challenge in planning: how to activate spaces to provide housing while at the same time protecting the natural environment. Urban growth should be spatially controlled and managed to avoid sprawling over natural landscapes and to also to avoid densification if it is at the expense of UGSs.

Many studies argue that compact urban form is the most sustainable urban form, while many others argue the opposite, and there is empirical evidence for both. And yet, there is a third group agreeing that sprawl is not a sustainable urban growth pattern, and also being critical about the viewpoint that just because compact urban form is the opposite of sprawl, it does not mean that compact is necessarily sustainable, for whatever positive meaning the word sustainability entails. Therefore, it seems like the question of either compact or sprawl is flawed: focusing only on urban form is inadequate and can be misleading in addressing the highly complex urban growth challenges. That is why it is necessary to think beyond the urban form and consider involving urban processes in the equation.

At this point, resilience concept is employed to align regional economic growth and environmental protection with the functioning of SESs. It is acknowledged that cities are complex, adaptive systems of permanent change, ongoing with a certain degree of uncertainty. Whether or not resilience thinking can help open up new ways of embracing and working with change will largely depend on its operationalization as an integral part of and parallel to urban processes.

In planning, resilience can be a very useful concept as it can make actors involved in planning and management processes to consider the social and ecological components of an urban system and how these subsystems are in constant interaction and producing and reproducing themselves. Resilience thinking also calls for acknowledging system properties such as resistance, adaptation, and transformation, and to embrace attributes such as complexity, uncertainty, and adaptive capacity. It is argued that in order to operationalize the resilience thinking in planning practice, it should be rather approached as a process that is integral to planning and management processes, than aimed as an end destination. Only then can resilience be effective in reaching the elusive goal of sustainable urban growth in general, and the sustainable development goal (SDG) 11 “make cities and human settlements inclusive, safe, resilient and sustainable” in particular.

References

Alberti, M., Marzluff, J. M., Shulenberger, E., Bradley, G., Ryan, C., & Zumbrunnen, C. (2003). Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. Urban Ecology: An International Perspective on the Interaction Between Humans and Nature, 53(12), 1169–1179.

Benedict, M. A., & McMahon, E. T. (2002). Green Infrastructure: Smart Conservation for the 21st Century. The Conservation Fund (Vol. September).

Bressers, H., & Bressers, N. (2016). Governance for drought resilience.

Campbell, S. (1996). Green Cities, Growing Cities, Just Cities? Urban Planning and the Contradictions of Sustainable Development. Journal of American Planning Association, 62(3), 296–312.

Chelleri, L. (2012). From the «Resilient City» to Urban Resilience. A review essay on understanding and integrating the resilience perspective for urban systems. Documents d'Anàlisi Geogràfica, 582, 287–306.

Chen, C., Doherty, M., Coffee, J., Wong, T., & Hellmann, J. (2016). Measuring the adaptation gap: A framework for evaluating climate hazards and opportunities in urban areas. Environmental Science and Policy, 66, 403–419.

Coaffee, J., & Lee, P. (2016). Urban Resilience: Planning for Risk, Crisis and Uncertainty.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (eds. (2016). Nature-based solutions to address global societal challenges. Gland, Switzerland.

Convention on Biological Diversity. (2009). Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change. Secretariat of the Convention on Biological Diversity. Montreal.

Costanza, R., D'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., … van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. Nature, 387(May), 253–260.

Dallimer, M., Tang, Z., Bibby, P., Brindley, P., Gaston, K., & Davies, Z. (2011). Temporal changes in greenspace in a highly urbanised region. Biology Letters, 7(March), 763–766.

Davern, M., Farrar, A., Kendal, D., & Giles-corti, B. (2017). Quality Green Space Supporting Health, Wellbeing and Biodiversity : A Literature Review, (March).

Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., … Davoudi, S. (2012). Resilience: A Bridging Concept or a Dead End? "Reframing" Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planning. Planning Theory and Practice, 13(2), 299–333.

Depietri, Y., Renaud, F. G., & Kallis, G. (2012). Heat waves and floods in urban areas: A policy-oriented review of ecosystem services. Sustainability Science, 7(1), 95–107.

du Plessis, C. (2008). Understanding cities as social-ecological systems. World Sustainable Building Conference, (2006), 1–9.

EEA European Environment Agency. (2004). Indicators for urban green infrastructure.

Eraydin, A. (2012). "Resilience Thinking" for Planning.

European Environment Agency (EEA). (2006). Urban sprawl in Europe - The ignored challenge. EEA report (Vol. 10).

European Environment Agency (EEA). (2010). Mapping the impacts of recent natural disasters and technological accidents in Europe - An overview of the last decade. EEA Technical report. https://doi.org/10.2800/62638

European Environment Agency (EEA). (2012). Urban adaptation to climate change in Europe-Challenges and opportunities for cities together with supportive national and European policies.

European Environment Agency (EEA). (2015). Urban sustainability issues — What is a resource-efficient city? EEA Technical Report.

Faivre, N., Fritz, M., Freitas, T., de Boissezon, B., & Vandewoestijne, S. (2017). Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges. Environmental Research, 159, 509–518.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chappin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. Ecology and Society, 15(4), 20–28.

Gago, E. J., Roldan, J., Pacheco-Torres, R., & Ordóñez, J. (2013). The city and urban heat islands: A review of strategies to mitigate adverse effects. Renewable and Sustainable Energy Reviews, 25, 749–758.

Goetz, S. J., Shortle, J. S., & Bergstrom, J. C. (2004). Land use problems and conflicts: Causes, consequences and solutions. Land Use Problems and Conflicts: Causes, Consequences and Solutions.

Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., & Briggs, J. M. (2008). Global change and the ecology of cities. Science, 319(5864), 756–760.

Grove, J. M., Cadenasso, M. L., Pickett, S. T., Machlis, G. E., & Burch, W. R. (2015). The Baltimore School of Urban Ecology: Space, scale, and time for the study of cities.

Haaland, C., & van den Bosch, C. K. (2015). Challenges and strategies for urban green-space planning in cities undergoing densification: A review. Urban Forestry and Urban Greening, 14(4), 760–771.

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. Source: Annual Review of Ecology and Systematics, 4(1973), 1–23.

Holling, C. S. (1996). Engineering resilience versus ecological resilience, National Academy of Engineering. In Engineering Within Ecological Constraints.

IPCC. (2007). Climate Change 2007: Synthesis Report. Climate Change 2007: Synthesis Report.

Kabisch, N., & Haase, D. (2013). Green spaces of European cities revisited for 1990-2006. Landscape and Urban Planning, 110(1), 113–122.

Keil, R. (2011). The global city comes home: Internalised globalisation in Frankfurt Rhine-Main. Urban Studies, 48(12), 2495–2517.

Kühnau, C., Böhm, J., Reinke, M., Böhme, C., & Bunzel, A. (2017). Doppelte Innenentwicklung – Perspektiven für das urbane Grün. Empfehlungen für Kommunen.

Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Folke, C., … Veldkamp, T. A. (2001). The causes of land-use and land-cover change: moving beyond the myths. Global Environmental Change, 11(4), 261–269.

Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: Synthesis. The Millennium Ecosystem Assessment series. Washington, DC.

Munang, R., Thiaw, I., Alverson, K., Mumba, M., Liu, J., & Rivington, M. (2013). Climate change and Ecosystem-based Adaptation: A new pragmatic approach to buffering climate change impacts. Current Opinion in Environmental Sustainability, 5(1), 67–71.

Naturschutzbund Deutschland. (2017). 30-Hektar-Tag 2017: Kein Grund zum Feiern. NABU. Retrieved May 31, 2019, from https://www.nabu.de/news/2017/06/22630.html.

Neuman, M. (2005). The compact city fallacy. Journal of Planning Education and Research, 25(1), 11–26.

Neuman, M., & Hull, A. (2009). The futures of the city region. Regional Studies, 43(6), 777–787.

Niemelä, J., Saarela, S. R., Söderman, T., Kopperoinen, L., Yli-Pelkonen, V., Väre, S., & Kotze, D. J. (2010). Using the ecosystem services approach for better planning and conservation of urban green spaces: A Finland case study. Biodiversity and Conservation, 19(11), 3225–3243.

OECD. (2011). Cities and Green Growth: A Conceptual Framework. OECD Regional Development Working Papers 2011/08.

Olofsdotter, B., Björnberg, K., Chang, H.-W., Kain, J.-H., Linn, E., & Scurrell, B. (2012). Synthesis Report: Competing for urban land.

Pauleit, S., Zölch, T., Hansen, R., & Randrup, T. B. (2017). Nature-Based Solutions and Climate Change-Four Shades of Green. In Nature-based Solutions to Climate Change Adaptation in Urban Areas Linkages between Science, Policy and Practice (pp. 29–49).

Pizzo, B. (2015). Problematizing resilience: Implications for planning theory and practice. Cities, 43, 133–140.

Regionalverband FrankfurtRheinMain. (2016). Potenziale für zusätzlichen Wohnraum im Siedlungsbestand der 50er- bis 70er-Jahre-Ergebnisse eines Modellprojektes für ein klimagerechtes Flächenmanagement.

Sassen, S. (2005). The global city: introducing a concept. The Brown Journal of World Affairs, XI(2), 27–40.

The Federal Government. (2002). Perspectives for Germany: Our Strategy for Sustainable Development.

The Resilience Alliance. (2010). Assessing resilience in social-ecological systems: Workbook for practitioners. Resilience Alliance, 54.

Walker, B., & Salt, D. (2006). Resilience thinking: Sustaining ecosystems and people in a changing world. Washington Cocelo London: Island Press.