Chapter

Promoting Partnership between Urban Design and Urban Ecology through Social-Ecological Resilience Building

Johan Colding, Lars Marcus and Stephan Barthel

Abstract

A closer partnership between urban design and urban ecology can yield new knowledge with the predictive advancement of both fields. However, achieving such partnership is not always a straight-forward process due to different epistemological departures. This chapter provides a rudimentary background of the fields of urban design and urban ecology and familiarizes readers with some epistemological characteristics that are useful to consider in all forms of partnership activities between designers and ecologists. Social-ecological resilience offers a useful framework for inquiry of particular relevance for urban transition at a time when global societal challenges of massive biodiversity loss and climate change require urgent attention and where wicked environmental problems require creative urban tinkering. Such a framework could open up for more dynamic research approaches with a greater potential to bridge the gap between design and ecology that has tended to be dominated by relatively static design approaches in the past, ignoring a more non-linear understanding of the interconnectedness of social and ecological systems. The chapter ends by focusing on some important determinants for cooperation and dealing with 'Research Through Design(ing)' as a viable methodology for transition to urban sustainability.

Keywords: ecosystem services, natural disturbance, research through design(ing), urban ecology, urban design, social-ecological resilience

1. Introduction

Cities are prime examples of complex adaptive systems [1] - something early on recognized by Jane Jacobs, who described cities as "organised complexity" [2]. Pickett et al. [3] characterize cities as "ecosystems" in that they are composed of biotic and abiotic, organic and inorganic matter. A city could also be described as an *anthropogeographical* landscape, as the famous Italian architect Vittorio Gregotti once preferred to call it, denoting an environment modified by the actions and presence of human beings. In this paper we view a city as an overlapping zone between culture

and nature that corresponds to the definition of an urban social–ecological system [4, 5], consisting of a set of critical natural, socioeconomic, and cultural resources (or, capitals). The flow and use of these resources are regulated by a combination of ecological and social systems, where the social system also includes technical systems [6]. At a micro-scale, individual buildings could be viewed as a microcosm of ecosystems, although they seldom integrate and express ecological elements and relationships in any profound and meaningful way. Hence, the process of designing and shaping the physical features of urban systems needs to be substantially improved in the transition to urban sustainability. Present-day urbanisation is, however, a particularly strong driver behind biosphere change, even to such a degree that it causes phenotypic changes in animal and plant populations [7]. Hence, we carefully need to think about how we design cities to more optimally support ecological determinants. Considering the global massive loss of biodiversity and ecosystem services (BES) [8], it is often argued that urban designers need to think more deeply about how cities should minimize their negative impacts on biodiversity [9]. Unless we do so, and given climate change, humanity faces the risk of crossing thresholds that will potentially trigger non-linear, abrupt environmental change with planetary-scale effects [10].

More crude and simplified forms of land-use classifications have for long made up the basis for decision making in urban planning [11]. The advancement of higher resolution multispectral imagery and an overall increase in scientifically derived knowledge at the local scale of cities [12, 13] have now made it possible to categorize the urban landscape in more detail. New attempts to combine descriptions in landscape ecology and urban morphology into a social-ecological spatial morphology have also opened up for planning and design of cities that bring the two fields together in a joint practice [14]. This provides new opportunity for designing and building cities with greater precision and could lead to a much closer coupling of urban design with urban ecology since it is at the local scales that urban designers tend to operate.

As urban design involves the physical organization of buildings and spaces towards a civic purpose, the authors behind this chapter argue that an important civic purpose is urban resilience building. *Resilience*, or the buffering capacity of complex adaptive systems [15], is the ability of people and human socio-cultural conglomerations to live and adapt to change [16]. The resilience approach emphasizes that social-ecological systems need to be managed and governed for flexibility and emergence rather than for maintaining stability. The authors behind this chapter also argue that social-ecological resilience offers a field of scholarship of particular relevance for urban design at a time when global ecological challenges require urgent attention [17]. Resilience thinking gives priority to more adaptive modes of urban designs that could more effectively respond to and deal with uncertainty and surprise and different types of disturbance [18]. Adopting resilience thinking in urban design is not a new idea. Pickett, Cadenasso, and McGrath [19] have devoted a whole volume to resilience building of urban design. Marcus and Colding [20], and Marcus, Berghauser-Pont, and Barthel [14, 21] have applied resilience thinking in urban spatial morphology, and Wilkinson, Porter, and Colding [17] have linked it to urban planning and design as a lens of inquiry.

1.1 Chapter outline

In this chapter we elaborate on how the science of urban ecology could partner with the profession of urban design, with the aim of enhancing social-ecological

resilience. Given climate change, cities need to increase their preparedness to adapt to natural disturbance such as amplified flooding, heat waves, storms and changing biological processes. Achieving greater partnership between ecologists and designers is, however, by no means a straight-forward undertaking. Previous attempts have tended to be dominated by relatively static design approaches, ignoring a more non-linear and complex understanding of the interconnectedness of social and ecological systems [22]. While the urban design field lately has experienced an upswing due to renewed concerns of a diminishing ecological and urban quality, urban environments still display surprisingly few deliberate attempts to integrate ecological functions in urban architecture and design [20, 23–25]. While architects and constructors by tradition have had difficulties in translating ecological concepts in physical building designs [26, 27] this shortcoming is likely also due to a failure of merging urban design with ecology in any meaningful way. Even educational curriculums at many higher education institutions lack a commitment to promote ecological issues [28, 29]. This raises profound questions as to how professionals, academics and practitioners in both fields could overcome the riddles and closing this knowledge gap.

The authors behind this chapter has structured the content herein as follows: We start by providing a short backdrop of some key theoretical epistemological characteristics that are useful to consider in any attempts of bridging urban design and urban ecology. We begin by presenting some historical examples of bringing nature into cities, and proceed with a presentation of some basic characteristics of urban design and urban ecology as well as how the two disciplines could potentially be linked. We continue by proposing resilience thinking as a useful framework for improving urban systems. While there are many ways in which a closer bridging of urban design and urban ecology can come about [30, 31], it is here argued that resilience thinking needs to be more intimately linked with urban design. The chapter ends by elaborating on how *Research Through Design(ing)* [32] offers a viable design methodology for addressing more dynamic, non-linear, and complex interconnections between urban ecology and urban design.

2. Epistemological departures

The integration of natural elements in the design of cities is not a new undertaking. Before the intellectual lineage of such prominent landscape designers and planners as Fredrick Law Olmsted, Ebenezer Howard, Patrick Geddes, and others, European cities of the 16th century were designed with nature elements. For example, Paris began to decorate its boulevards with trees already in the 17th century - a practice that quickly spread so that by the 19th century street trees became the fashion in most European cities. These design attempts served not only aesthetic purposes. In fact, both Frederic Law Olmsted and Ebenezer Howard perceived natural elements in cities to provide functions to humans that we today would refer to as 'ecosystem services.' Olmsted spelled this out almost 150 years ago in his seminal paper *Public parks and the enlargement of towns* (1870) [33]: "Air is disinfected by sunlight and foliage. Foliage also acts mechanically to purify the air by screening it".

Following the urban park movement of the 19th century, Ian McHarg's work *Design with Nature* from 1969 renewed urban comprehensive planning by integrating ecology into city design. The applicability of systematic land-use planning in determining areas of development and areas for conservation, involving the map overlays of different natural features (e.g., hydrology, geology, soils, vegetation, and wildlife), is representative

of this approach [34]. While Ian McHarg advanced the inclusion of ecology in the field of landscape architecture, he has been criticized for promoting an unappealing view of urban areas and for promoting a deterministic and anti-humanistic view in planning that disregards social values in the design process.

Among the different types of urbanisms that have emerged since the arrival of New Urbanism in the early 1980s and the charter of the New Urbanism in 1993 by Peter Calthorpe and colleagues, landscape architect Peter Connolly is often credited as having introduced the term 'landscape urbanism' into the design discourse in the early 1990s. It comprises a theory of urban planning in which landscapes replace architecture as the building block of organizing cities. The phrase 'landscape urbanism' first appeared in the mid 1990s, but has taken on many different uses, although most often cited as a postmodernist or post-postmodernist response to the 'failings' of New Urbanism and a shift towards environmental sustainability and ecology as a metaphor [35].

2.1 Urban design

Urban design is a humanist field that has grown over the last 50 years, and particularly so over the last two decades with a rapid growth of the discipline at universities, in academic journals, and as a subject for academic research [36]. While urban design involves an understanding of a wide range of subjects from physical geography, ecology to social science, and an appreciation for disciplines such as economics, political economy and social theory, the concept of 'urban design' is quite fuzzily defined in the literature, and a more precise definition has not yet been broadly accepted. At the birth of the urban design field in the United States at the Harvard Urban Design Conference in 1956, the conference convener, José Luis Sert, defined urban design as "that part of city planning which deals with the physical form of the city" [37] (p. 587). Urban design was in Sert's view a subset of urban planning that he described as "the most creative phase of city planning, in which imagination and the artistic capacities play the important part" [37]. Sert initiated the world's first degree-program in urban design at Harvard where he also brought art into the curriculum.

Urban design can be regarded as "an art or technical practice involving the physical organization of buildings and spaces, towards a civic purpose" [38] (p. 258). It draws on a wide range of scientific theories and artistic approaches, including Gestalt theory, postmodernism, information science and biophilia [38]. In textbooks urban design more generally denotes both the process and end-result, or artefact, of crafting places in cities and towns [35]. Lenzholzer, Duchhart, and Koh [32] (p. 121) distinguish between designing and design, the former signifies "the process of giving form to objects or space on diverse levels of scale", the latter signifies "the results of a design process". Hence, a normative definition of urban design could be the process of shaping places for people [36]. Urban design theory has, however, been criticized on grounds that it lacks a coherent theoretical basis of its own and as a partly pseudo-scientific field based on norms rather than on scientific validity and treating hypothetical suggestions and assertions as facts [38, 39]. It has also been criticised for a lack of scientific rigor that could lead to the stagnation of the design field itself [40].

2.2 Urban ecology

The study of the ecology *in* and *of* cities [3] arose in the early 1970s as a subdiscipline of ecology and has continued to develop into a distinctive science over the

last 30 years. Interestingly, however, is the fact that urban systems for long were neglected by ecologists, witnessed in that only a mere 0.4 percent of all published papers in the nine leading ecological journals dealt with cities two decades ago [41]. More specifically, urban ecology represents a natural science field that could be defined as the study of the co-evolution of human-ecological systems [42]. While urban ecology is an amalgamation of several disciplines [43], it is primarily concerned with the description, prediction, and understanding of natural phenomena, based on observational and empirical evidence. Comprising a subset of ecology, it involves the scientific study of the relationship of living organisms and their distribution and abundance in and around cities, and on the biogeochemical budgets of urban areas [3]. Urban ecology grew in the 1990s with the concepts of ecological footprints [44], extended versions of urban metabolism [45], and with research on urban ecosystem services [46], patch dynamic studies and high-resolution land cover classification (see e.g. [47]).

Much knowledge concerning how urbanization changed ecological patterns and processes has been generated by way of quantitative analysis of urbanization gradients [48], which provide a broad generalization of features of the urban landscape. Such studies generalize the urban landscape, but does not quantify its underlying specific features such as e.g. how specific urban forms affect animal dynamics at finer scales of cities [49, 50]. Thanks to the improvement of higher resolution multispectral imagery it is now, however, possible to quantify the effects of individual urban features on biodiversity levels [12]. Urban ecologists are also increasing their efforts to understand how species *behave* at finer levels of the city, i.e., at the cognitive level of urban space [20, 50, 51]. Ecological qualities at this level could be referred to as 'perceptual qualities' [39] and as urban designers also tend to operate at this level, it is precisely at the micro-scale of cities that we see the greatest potential for increased cooperation between urban designers and urban ecologists.

3. Linking urban design and urban ecology

Batty [52] has suggested that the bridge between science and design is contained in the notion of prediction of the future. In this view science could be seen as a process about understanding the present in contrast to design, which is a process about inventing the future. As Batty puts it: "In contrast to science, design is about the future, about future knowledge and its evolution […] The present in no sense is plannable or controllable whereas the future surely is: thus, design is active in contrast to science which is rightly or wrongly regarded as passive" [52] (p. 154).

The distinction between how the world 'is' and 'ought to be' stems from the philosopher David Hume, and has remained a way of distinguishing the prerogative of science from that of design [38]. Hence, following Batty's line of argument, the key mission of urban design is to probe and invent new ways or designs to be further empirically tested in scientific studies. In Batty's terminology the design process is therefore as active as it is cyclic over time and often needs to be fine-tuned and improved over considerable time periods.

As the professional field of urban design is a humanist field that adopts methods that are primarily critical, or speculative, as distinguished from the science of ecology, one might question if it is possible or even desirable to merge the two fields. Some critics, for instance, object against the 'scientization' of urban design and question whether it can be reduced to scientific scrutiny. Architectural theorist Bill Hillier

argues that the design process is a coming together of different knowledge forms, essentially generative knowledge about 'how things could be' and more scientific knowledge about 'how things are', where the latter in the design process have the role of, so to speak, correcting potential solutions of a designer and directing them into more appropriate solutions [53]. Such knowledge may be generated from urban design research and embodied in urban design theory [53] (p. 265).

Urban ecology could contribute to urban design theory by adding scientific validity and rigor when adopted in design research. It can also outline key challenges - i.e., climate change, biodiversity loss, ecosystem restoration projects, smart city digitalization etc. - that designers could grapple with and find tentative solutions to in various collaboration projects. Conversely, design with its aim on the future, could revitalize urban ecology by providing new perspectives, novel frames of analysis and new ways of thinking about urban social-ecological systems. Such partnership could create new research opportunities for ecologists [54]. For example, layouts, artefacts, ergonomics, and construction are elements that designers use that could help visualize things for ecologists. An important characteristic of the design process is the use of different types of drawings [55] and pictorial representations that serve the role of connecting expertise and innovation [56]. Drawings and other artwork that are developed by designers can also be used to structure discussions around, and formulate design elements as well as creating a mutual language between ecologists and designers. For ecologists to partner with designers could be especially worthwhile in order to find new solutions to confer social-ecological resilience in urban systems. Hence, working together with designers, ecologists could engage in inventing new concepts and technologies to accomplish this goal.

3.1 Social-ecological resilience as a linking framework

Considering the great challenges that humanity presently is facing, we suggest that research collaboration between ecologists and designers should primarily focus on the enhancement of social-ecological resilience. According to Erixon Aalto, Marcus, and Torsvall [22], attempts of bridging the gap between design and ecology has traditionally been dominated by relatively static design approaches, ignoring more non-linear and complex understanding of the interconnectedness of the social and ecological systems (but see e.g. [19]). Furthermore, they argue that contemporary urban design practices primarily tend to incorporate ecological issues in the prescriptive and preventive aspects of projects, and using ecologists mainly as consultants in various design proposals. Also, the main contribution made by ecologists often concerns the collection and classification of data about existing situations and seldom involves more future-oriented probing.

Central to a more dynamic and non-linear understanding of the interconnectedness of urban ecology and urban design that Aalto and colleagues are calling for, is a shift of focus where humans become resituated from being outside ecosystems to one being integrated within them, or more precisely "as stewards 'navigating' the system from within" [22] (p. 1). In this way, humans become co-creators of nature through the integration and management of ecosystem services in urban design projects and by adopting social-ecological resilience thinking as a guiding design principle [57]. The notion of social-ecological resilience reflects to a great deal the degree to which a complex adaptive system is capable of self-organization and build capacity for learning and adaptation [58]. Part of this capacity lies in the regenerative ability of ecosystems to continue to deliver ecosystem services essential for human livelihoods

and well-being in the face of change and/or disturbance. Viewing cities as ecosystems (sensu [3]) means that ecosystem services become a key design- and management objective for the resilience building of functioning cities.

3.2 Conditions for cooperation

Whereas a closer partnership between urban design and urban ecology could yield new knowledge that could advance both fields, it is equally important to ask where such knowledge is best put to practice. For one thing, and adopting a resilience approach, it will be increasingly critical to find solutions to curb the dangerous interactive effects of urbanization, climate, and human health [59]. For example, climate induced natural disturbance such as fires, droughts and floods will have great adverse consequences both for humans and non-human species and could cause great damage to human physical conglomerations and infrastructures. Hence, Palmer et al. [59] propose that the creation of *designed ecosystems* represent one area where designers and ecologists could cooperate. Designed ecosystems involve coming to terms with slightly disturbed ecosystems through human manipulation as well as creating entirely new ecosystems where other alternatives do not exist. The latter should serve a combination of ecological, social, and economic purposes.

Facilitating so called *designed experiments* into the urban mosaic is another approach that could be harnessed, where the aesthetics and functions of urban design could be put to use with both ecological ends and social goals [54]. While both examples represent suitable areas for collaborative intervention, it is also critical to consider how such cooperation best can come about. As stated earlier, previous attempts have been dominated by more consultant-based relationships where various ecological issues have been incorporated in projects, ignoring more deeper forms of cooperation between designers and ecologists. Having a common framework to base cooperation around seems to be highly fruitful. Erixon et al. [22] used resilience thinking as the basis for such cooperation when constructing a vision for a new university area in Stockholm, Sweden. The principles underlying this work are outlined in Barthel et al. [57]. Applying resilience thinking in workshops that gather urban planners and other urban professionals has been found to be highly successful in research [17]. Educating urban designers about biodiversity and ecosystem services could also be an important aspect of improving the conditions for cooperation between urban designers and urban ecologists.

3.3 Research through design(ing) as a bridging methodology

Finding a common working methodology is another important factor to consider. In this context, *Research Through Design(ing)* (RTD) [32] offers an interesting design approach for addressing more dynamic, non-linear, and complex interconnections between urban ecology and urban design due to its alignment with ideas that are central to resilience thinking. The RTD-methodology views the designing activity as a research method in itself, elucidating a dynamic view of urban systems in recognition of that things change and that designing is seen as a process rather than an end product. It involves creating design propositions and/or artefacts and test them in an iterative fashion, and thereafter refine and calibrate the design. The methodology therefore satisfies the juxtaposition of the science- and design process called for by Batty [52], displaying an iterative relationship between science and design (**Figure 1**). Such a probing, where knowledge is gradually accumulated and continuously evaluated and

Figure 1.
The iterative relationship between science and design. Observations and scientific theories are used to make predictions of the future that can be probed and tested on specific problems to generate new design solutions that either could be refined through making new predictions, or generate new knowledge that contributes to theory development. Adapted and modified from Batty [52].

refined is also an important mark of resilience thinking where uncertainty and surprise are considered crucial parts of the management process [15] in recognition of that complex adaptive systems always exhibit a limited degree of predictability [60, 61].

The RTD-methodology shares also many features of *adaptive management*, which is a central tenet in resilience management, entailing the testing of different management policies, treating policies as hypotheses and the whole management process as an experiment from which managers can learn [61, 62]. This also involves *social learning* at the level of society, expressed in dynamic institutions and flexible management policies [63]. The sub-optimal outcomes that often are the result when managing complex adaptive systems are mirrored in the prognostic models of urban design due to that "new design relevant knowledge concerns future states of the environment that cannot be evaluated by empirical methods" [64] (p. 6).

The RTD-methodology is ultimately rooted in constructivism and therefore also entails studies on people's attitudes, beliefs, and experiences, affirming that people actively construct or create their own subjective representations of objective reality. Data gathering this way is often achieved through participatory observation and interviews [32]. The knowledge generated cannot be generalized, but is contextually based, the same way as many ecological relationships are related to a specific place or situation. However, it can be used for further comparative studies and be fine-tuned and calibrated over time.

The RTD-methodology also involves action-oriented research for bringing about change of a situation and to raise awareness among participants – an important determinant in any form of transition to sustainability. Hence, it can facilitate processes that empower a community or group of people that are part of the design process [65] and it therefore share many features of collaborative planning and its concern with the democratic management and organization of urban environments [66].

Erixon Aalto, Marcus, and Torsvall [22] describe how their design of a new university campus involved a transdisciplinary design process, comprising both professionals and researchers from the fields of ecology, urban design and architecture, landscape design, as well as local interest groups, planners, and developers. The group therefore organized and performed a series of workshops and meetings with civil society groups that had a stake in the area where the new campus is now located, making sure that their opinions and experiences were taken into account in the creation of the design vision [57]. Similar to the RTD-methodology, the group nurtured *adaptive co-management* where knowledge and expertise of different actors and stakeholders are put together in order to increase the chances for management success and for avoiding potential conflicts. Adaptive co-management acknowledges the important role that local institutions, norms and social networks play for resilience building of integrated social-ecological systems [67, 68].

The RTD-methodology embraces a pragmatic approach to design, adopting the notion of "what work works" [32] (p. 125). With its roots in the U.S. around 1870, and drawing upon such prominent philosophers as William James, John Dewey and others, pragmatism applies a practical approach in solving problems in situations when knowledge is incomplete, emphasising the application of best available knowledge. The RTD-methodology also draws on multiple knowledge paradigms and involves "a series of different studies carried out in parallel or in sequence" [32] (p. 126). Research questions could, for example, comprise natural and cultural aspects as well as design options, often within a specific geographical context. It could also involve specific redesigns of urban spaces against climate change, studies of how new climate responsive designing can change people's mind sets, as well as how to create participatory action amongst citizens to adjust cities to the current challenges of our time. The strength of the pragmatic RTD methodology is that various knowledge paradigms and methods can enhance and complement each other; hence, science and design hold potential to be intertwined and progress in an iterative fashion.

4. Conclusions

Future urban environments will consist of human-influenced ecosystems that to varying degrees need to be managed in order to sustain ecosystem services [59]. This chapter has focused upon conditions that could promote a closer partnership of urban design and urban ecology. Such partnership, we argue, is especially warranted at a time when global ecological challenges of massive biodiversity loss and climate change require urgent attention and where wicked environmental problems require creative urban tinkering that involves adaptive probing, testing, and refining due to the inherent unpredictability of these challenges [69]. While there exist many ways in which a closer bridging of urban design and urban ecology can come about, we have here dealt with the specificities of both disciplines and highlighted some snags in the formation of such partnership. We have also suggested that collaboration to a greater degree should be centred on the sharing of a mutual framework that is geared at enhancing social-ecological resilience in urban systems, particularly so in urban projects that involve designed ecosystems and various designed experiments in the urban mosaic. The methodology referred to as Research Through Design(ing) share some key characteristics with resilience thinking, rendering it particularly useful for enhanced cooperation between urban ecologists and urban designers. For one thing, it holds a real potential to strengthen the scientific rigor of urban design and can as well invigorate urban ecology by providing new perspectives, novel frames of analysis and new ways of thinking about the future of urban systems. Suffice to say, a closer bridging between urban ecology and urban design could positively contribute to a faster and more fair and inclusive transition to urban sustainability.

Acknowledgements

Johan Colding's and Stephan Barthel's work have been funded by the Department of Building Engineering, Energy Systems and Sustainability Science at the University of Gävle, and is part of the Urban Studio program. Johan Colding's work has also been partly funded through a research grant (reference number: 2017-00937) received from the Swedish Research Council for Environment, Agricultural Sciences and

Spatial Planning (FORMAS), and through means provided by the Beijer Institute of Ecological Economics, Stockholm, Sweden. Barthel's work has also been funded by FORMAS/The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning. The project is called Spatial and Experiential Analyses for Urban Social Sustainability (ZEUS) (reference number: 2016-01193). Lars Marcus' work has been funded by the Department of Architecture and Civil Engineering, Chalmers University of Technology, Gothenburg, Sweden.

Conflict of interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Author details

Johan Colding[1,4*†], Lars Marcus[3†] and Stephan Barthel[2,4†]

1 The Beijer Institute of Ecological Economics, Royal Swedish Academy of Sciences, Stockholm, Sweden

2 Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden

3 Department of Architecture and Civil Engineering, Chalmers University of Technology, Gothenburg, Sweden

4 University of Gävle, Gävle, Sweden

*Address all correspondence to: johanc@beijer.kva.se

† These authors have contributed equally.

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