Plugging urban ecology science into design practice: a research perspective

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ABSTRACT
There is a broad consensus that urban ecology science needs to be more effective in informing and supporting urban planning and design. How to bridge the two disciplines is still a grand challenge because scientific research often cannot find its way into practice. Underlying reasons have often been explored around governance, policies and institutional aspects. From a scientific research perspective, this paper briefly outlines the divergence between the two disciplines and seeks potential intersections of them. Overall, starting from the practical needs, this paper argues that there are many “plug-in” opportunities that should be explored in the whole research chain to accommodate successful co-development of research in practice, such as sharing similar research interests, jointly identifying research questions and objectives, adopting suitable research methods, well-designed research experiments and parameters (e.g., matched scales, resolution levels, metrics and indicators), co-collection of site-specific data. Furthermore, this exploration can be enhanced, particularly at a local scale, where urban dwellers’ perceptions, interests and the consequent influences on decision-making and actions can be well incorporated.

Introduction
As an important component of cities, blue-green space provides a wide range of ecosystem services that contribute to urban sustainability, health and livability. However, because cities all over the world are the outcomes of human construction, the extent to which such functions and services are provided is influenced by the ways of urban planning, design, engineering and management. All these have led to an “ecology in or of city” being more complex and multifaceted. President Xi Jinping once stated: “... Scientific planning generates the greatest efficiency; planning failure produces the greatest waste, and whimsical planning is the greatest taboo”(Chinanews 2015; Lance L P Gore 2015). Although ecology science often concentrates on studies of land use/cover change and landscape patterns alike, there is no doubt that the accumulated decisions and processes of planning and design of the human environment explicitly bring about these changes on the ground, set up long-term patterns of economic development, and influence people’s ideology toward nature.

Globally, ecologists have reached a consensus that the urban ecosystem is a novel system with the “socio-ecological” dual attribute; they are aware of the necessary foundational role of ecology science in informing and supporting urban planning and design practice. A close combination of these two “science-practice” disciplines has been greatly encouraged (Pataki 2015), such as using technologies of blue-green infrastructure and nature-based solutions (Evans et al. 2022; Wild, Henneberry, and Gill 2017). However, how to effectively bridge the two very different disciplines to achieve a real binding is still a challenge. The path of science to practice has remained elusive across many disciplines. The barriers behind this are largely attributed to mismatched policies, institutional ineffectiveness, governance processes and lack of collaborative or coordinated actions (Briggs and Knight 2011; Perrings et al. 2011; McDonald et al. 2019). This perspective briefly outlines the divergence between the two fields and attempts to seek potential intersections between them and an approach to this challenge from a scientific research perspective.

Divergence between the two fields
Urban planning, design and suchlike practical disciplines are characterized by holism and systematism because they deal with a whole project on a real-world site. They are oriented to seeking solutions and thus require information, knowledge and technology that are well-legible, spatially visualized and site-specific. In this process, their practice behaviors, values, expectations, attitudes and norms of planning and design are gradually forming. All these comprise the practice culture to serve social and economic needs. For example, for a landscape restoration project, these disciplines would propose an overall solution for the site according to the demands of the clients (which depends on the political system – usually they are
governments that represent interests of people in China, or landowners/stakeholders who make direct demands). In comparison, the philosophy of scientific studies is inclined to be reductionist – dividing complex systems or phenomena into a series of smaller, simpler parts to describe and understand. These studies are often driven by the science community’s intrinsic curiosity. The process and the findings focus on exploring the natural laws and underlying mechanisms that often possess qualities of abstractness and generalization. Obviously, scientific research does not aim at practice or implementation. Additionally, the science of ecology has developed many categories over more than 100 years, including autecology, synecology, ecosystem ecology, landscape ecology and agricultural ecology. Studies are often published in partitioned pieces and are widely spread in forms of rigid data, tables and cumbersome analyses across many different international journals. Vital and layman-friendly information required by practitioners is often not considered appropriately by ecologists. These factors inevitably build barriers that make it difficult for practitioners to access the findings, far less synthesizing the information and using them.

Furthermore, in terms of the scientific research process and performance on both sides, there are differences through every step, i.e., in the research objectives, research methods, spatio-temporal scales, resolution levels, measurement methods, parameters and metrics that are applied. For instance, ecosystem services assessment studies often focus on major issues, such as the services of water resources balance, carbon sequestration and food production alike at a large scale; local functions and services that are widely distributed and in close contact with people’s daily life are generally overlooked, and even less mentioned are urban dwellers’ cultural and spiritual needs derived from ecosystems. Similarly, studies on land use/cover change and its consequent effects often explore the temporal and spatial characteristics and patterns of urban spatial development, but do not trace back to the practice of urban planning and design that has caused the change. In other words, there are no direct connections between such studies and the parameters, measures and codes regarding urban planning and design, such as building density and plot ratio. Thus, the corresponding findings, conclusions and strategies from these studies cannot be directly used to influence or change the codes and regulations of urban planning and design. Therefore, it is not difficult to understand why ecological research frequently does not find its way into practical actions.

Starting from the intersections of the two fields

Given the divergent cultures of the two fields, this perspective advocates co-development for research, i.e., the two fields should share similar research interests, jointly identify research questions and objectives, co-collect site-specific data, adopt suitable research methods and co-design research experiments and parameters. Overall, starting from the practical needs, there are many “plug-in” opportunities that should be explored in the whole research chain to adjust research to practice (Figure 1). Here, two examples of high relevance to both fields are presented for such co-research development.

Urban plant diversity research to design practice

Research on urban plant communities and biodiversity has gradually accumulated interesting findings and results. On the other side, urban plant communities are major entities of urban planning and design. The similar research interest can be an intersection that nurtures co-development of research questions, where urban designers and ecologists shall work jointly on how urban plant diversity research can support indigenous species selection, species composition, species recruitment patterns, planting patterns and design strategies to fostering biodiversity in cities. This is a shift from analyzing urban biodiversity to re-shaping urban biodiversity. For instance, in a national study of 257 cities in China, Lhasa’s urban forest has a similar species composition to Beijing’s urban forest that is a thousand kilometers away (Yan and Yang 2017). If, at the start, urban plant diversity research had been incorporated into the early stages of urban landscape design and projects, this could

Figure 1. A conceptual framework illustrating “plug-in” ways for adjusting ecology research to design practice.
have reduced the homogenization of species composition and structure among cities. This attempt is increasingly recognized, with “Designed Experiments” that embed ecological research (such as hypothesis testing, specific research methods applied) into urban design in building landscapes and other infrastructure to enhance integration at the science-design interface (Felson, Bradford, and Terway 2013).

People-Centered ecosystem services research to design practice

The goal of evaluating ecosystem services is to assist decision-makers optimize ecological protection planning and management to promote sustainable development of human society and the natural environment. They have often been integrated in many Chinese cities with ecological planning, urban planning and land use planning, where “ecological priority areas” and “ecological redline areas” can be conveniently determined (Bai et al. 2018). This paper argues that such research breadth and depth can be extended toward serving local scale design ends (site-, neighborhood-, place-scales), given the growing behavioral sciences that systematically analyze people’s perceptions, judgments and the consequent influences on decision-making and actions. Incorporating the behavioral sciences into ecosystem services at a local scale could help reveal the motivations and reasons behind unsustainable practices (Klotz, Pickering, and Weber et al. 2019). A recent example is that a Shanghai resident was fined heavily for over-pruning a camphor tree close to his flat because the luxuriant tree blocked sunshine all year round and severely affected his family’s daily life (CCTV News 2021). Another example is that there generally set up functional areas in urban parks, such as an elderly persons’ activity area, youth activity area and children’s playground, so people at different ages would have corresponding expectations and needs regarding ecosystem services around them. If our research incorporated trade-offs between ecosystem services at a local scale (e.g., people’s daily experiences and perceptions of living comfort and urban ecological functions, in above cases) through dwellers’ engagement at the beginning of urban development (residential area, green/blue space, etc.), more effective alternative planning/design strategies could be nurtured. Reasonably targeting local people’s concrete welfare (such as health risk, property damage and daily activity needs) and allowing the people to influence decision-making processes is of the most importance especially in the urban living environment, because after all cities are built by people and fundamentally serve people’s needs.

Conclusions

Bridging science and practice together is intractable particularly for urban ecosystems since it is a novel approach with more uncertainties than wild environments. From a scientific research perspective, innovative interdisciplinary co-research should be a requirement for urban ecological practice. Such practice has started by being featured in China’s new Territory Spatial Planning System (Xinhua News 2019) under the goals of eco-civilization (China Environment News 2018). However, such a practice might have historically meant nothing more than decoration or aesthetic since they were deep-rooted in traditional private gardening. Compared with those high-profile political agendas and development planning, design at the local scale regarding the selection of plants, planting modes, city-dwellers’ interests, practice culture and behavior has so far been underestimated and underused. This perspective presents two examples for possible co-research development based on urban plant diversity and people-centered ecosystem services. It is worth pointing out that we do not claim that the two possibilities are all that can be said about plugging ecology research into design practice. Scientific communities should take the initiative to work with practitioners and dwellers alike to work out the linking paths and so yield implementation-oriented, readily-useable ecological strategy portfolios through well-designed ecological research.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was based on “Effects of urban designed environment on urban plant biodiversity and feedback to urban planning and design practice”, financed by the National Natural Science Foundation of China (NSFC) [Grant No. 52078346]. It is with great gratitude to NSFC for supporting this transdisciplinary research. I received the acceptance letter on my tenth anniversary of professional work. I regard this perspective as summarizing me having a foot in both camps – one foot in ecological science and the other in planning and design practice. Thank anonymous reviewers and editors for their constructive comments.

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