**Response to Kabisch et al.**

*Jesse T. Rieb, Rebecca Chaplin-Kramer, Gretchen C. Daily, Paul R. Armsworth, Katrin Böhning-Gaese, Aletta Bonn, Graeme S. Cumming, Felix Eigenbrod, Volker Grimm, Bethanna M. Jackson, Alexandra Marques, Subhrendu K. Pattanayak, Henrique M. Pereira, Garry D. Peterson, Taylor H. Ricketts, Brian E. Robinson, Matthias Schröter, Lisa A. Schulte, Ralf Seppelt, Monica G. Turner, Elena M. Bennett*

Kabisch et al. (2017) reviewed our call for advances in ecosystem service (ES) decision-support tools from an urban perspective, and explored how the three research frontiers we identified should be considered in cities. We appreciate how they build on our original ideas, and welcome this as a good example of how the general principles we developed in the original paper can be applied and adapted to specific contexts. In fact, we believe that similar points about the importance of adapting our general principles for specific social-ecological systems could be made for many other systems, such as marine ecosystems or managed forestry systems. The specific characteristics of these different systems also provide opportunities to expand on current ES knowledge and improve ES management tools. For example, as Kabisch et al. (2017) point out, cities are unique due to their relatively small area and high population density, which may make them more ideal than other systems for understanding certain aspects of the linkages between humans and nature and for implementing this understanding in management tools. We take the opportunity to respond to the ideas presented by Kabisch et al. and thus continue the conversation around urban ES.

Kabisch et al. suggest that remote sensing is less useful in urban areas. However, remote sensing has been used very effectively in cities to model heat regulation (Schwarz et al. 2011), carbon storage (Tigges et al. 2017), and flood regulation (Wirion et al. 2017), among other ecosystem services. The small scale and contained nature of cities may allow for additional methods to be used in conjunction with remote sensing, such as participatory mapping (Plieninger et al. 2013) or direct measurements such as tree inventories (Nielsen et al. 2014). Using multiple methods may provide more complete information than remote sensing alone (Cord et al 2017), leading to a more comprehensive understanding. Building tools that can utilize multiple knowledge sources and produce diverse types of information would allow urban areas to leverage these alternative data sources to improve ES management.

Kabisch et al. also call for simplification of ES models and tools to make them accessible to a broad range of stakeholders, many of whom are underrepresented in current environmental decision-making processes. While we support efforts to make ES decision-support tools more democratic, we argue that a renewed focus on landcover-based tools, which have a number of disadvantages as laid out in our original article, is counterproductive. Instead, we suggest shifting the focus of simple ES decision-support tools away from land use and land cover and towards the ecosystems and environmental processes that actually produce ES, as well as the interactions between people and nature that support co-production of ES in highly human-influenced landscapes such as cities. (Luck et al. 2009, Ziter 2016). We also suggest that models be developed to provide metrics that support different types of decision-making, including problem scoping and definition, assessment of alternatives, implementation planning, and evaluating previous management actions. Such an approach could still be tangible to diverse stakeholders, including those without scientific backgrounds, while providing a more accurate assessment of ES and supporting a broader range of decision contexts. Where urban areas are a focus, the small spatial scale of cities and other human settlements would facilitate the collection of the detailed ecological data necessary to build and apply these types of tools.

As Kabisch et al. point out, and as we highlight as one of our core frontier areas, it is crucial to integrate beneficiaries into ES tools, and to acknowledge how different populations access (or lack access to) ES. Kabisch et al.’s suggestion of a “multi-method approach” is one promising way to address these issues. We also highlight the importance of working closely with stakeholders, not only when using tools to design management strategies but also through co-design of the tools themselves and through citizen science approaches (Schröter et al. 2017). This allows integration of diverse perspectives through the ES modeling process (Jacobs et al. 2016). Although we believe that this is important in all types of ES assessments, cities, with their defined boundaries and existing structures for social organization, offer excellent opportunities to pilot and test some of these strategies.

Though we expect social processes and telecouplings to play important roles in many systems, they exert an outsized influence on the provision of urban ES (Yang et al. 2016). Because of this, development of tools that account for these processes is crucial to understanding the provision of ES in urban areas. The high dependence within cities on technology and reliance on flows of services from other locations offer advantages for understanding the integrated role of social and ecological processes in ES provision and use. For example, it might easier to determine the limits of technology and telecouplings’ abilities to substitute for local natural capital in ES provision in cities than in other locations.

Kabisch et al.’s viewpoint serves as a useful companion to our original article. However, we urge caution around their call for redrawing the focus of our ES modeling frontiers towards cities. Cities contain a large and increasing proportion of the earth’s population, and urban ecosystems may play a disproportionate role in providing certain ES, such as temperature regulation, air purification, or aesthetic benefits, due to their proximity to people. However, urban areas still only contain a very small proportion of the earth’s land area. Other non-urban types of land use cover the vast majority of the earth’s surface and provide important ES to people living in both urban and rural areas, including climate regulation, water purification, and provision of food, water, and raw materials. Thus, we encourage even urban-focused ES studies to recognize the diverse types of social-ecological systems, both within and outside of cities, that support human well-being through ES provision.

All social-ecological systems that produce ES are complex in unique ways, which complicates the task of building generalized tools that can be used across different contexts. However, each system also provides opportunities to expand our understanding of different aspects of ES that are necessary for building such generalized tools. We welcome work such as that by Kabisch et al. that explores our frontiers from the perspective of a particular system, and we hope that such work will push us closer to the achieving the advances we called for in our original paper.

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