The role of socio-economic factors in planning and managing urban ecosystem services

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How green spaces in cities benefit urban residents depends critically on the interaction between biophysical and socio-economic factors. Urban ecosystem services are affected by both ecosystem characteristics and the social and economic attributes of city dwellers. Yet, there remains little synthesis of the interactions between ecosystem services, urban green spaces, and socio-economic factors. Articulating these linkages is key to their incorporation into ecosystem service planning and management in cities and to ensuring equitable outcomes for city inhabitants. We present a conceptual model of these linkages, describe three major interaction pathways, and explore how to operationalize the model. First, socio-economic factors shape the quantity and quality of green spaces and their ability to supply services by influencing management and planning decisions. Second, variation in socio-economic factors across a city alters people's desires and needs and thus demands for different ecosystem services. Third, socio-economic factors alter the type and amount of benefit for human wellbeing that a service provides. Integrating these concepts into green space policy, planning, and management would be a considerable improvement on 'standards-based' urban green space planning. We highlight the implications of this for facilitating tailored planning solutions to improve ecosystem service benefits across the socio-economic spectrum in cities.
can influence ecosystem service benefits. For example, Shanahan et al. (2013). Importantly, recent research has started to address in urban planning policy or scholarship. Thus, spatiotemporal variation in socio-economic factors within cities can lead to significant variability in the supply and demand of ecosystem services derived from green spaces (McDonald, 2009; Escobedo et al., 2011). This means that the relationships between socio-economic factors and ecosystem services should be a key planning and management consideration (Cowling et al., 2008; Lyytimaki and Sipila, 2009; Gómez-Baggethun and Barton, 2013), despite rarely being addressed in urban planning policy or scholarship.

Three key insights about the role of socio-economics in urban ecosystem services are currently evident from the literature and all hinge on ‘differences’: (1) green spaces are perceived and used differently by different demographic groups (e.g., Madge, 1997; Tinsley et al., 2010), (2) there are often inequalities in green space provision along socio-economic gradients (e.g., Pedlowski et al., 2002; Pickett et al., 2008), and (3) the types and importance of ecosystem services to urban residents can differ along socio-economic gradients (e.g., Tratalos et al., 2007; Lubbe et al., 2010; Cilliers et al., 2013). Importantly, recent research has started to reveal the potential mechanisms by which socio-economic factors can influence ecosystem service benefits. For example, Shanahan et al. (2015) showed that higher formal education levels and greater neighborhood socio-economic advantage are associated with the use of local parks that incorporate native remnant ecosystems. Additionally, Peterson et al. (2008) showed that residents choosing to live in more natural areas were older, better educated, and more environmentally-oriented than those choosing residential areas with less green space.

With such evidence accumulating, there is an urgent need to bring these threads together to improve the conceptual understanding of how socio-economic factors influence ecosystem services in cities that can then be operationalized for urban planning. Such a model could then directly improve ecosystem service management by delineating and linking ecosystems service components such that urban policy-makers, planners, and managers can more clearly consider critical contextual factors in their focal areas (Cowling et al., 2008; Luederitz et al., 2015). Without this, there is the risk that planning initiatives to improve the quantity or quality of green space across cities will result in fewer or less equitable benefits for city inhabitants. We note here that, while some decision-making factors for private spaces differ from those for public spaces, planners and managers must influence both for equitable ecosystem service provision (Aronson et al., 2017). Many cities have simple prescriptive targets for green space quantity and spacing that are intended to provide equal access (Heynen et al., 2006), but these well-meaning targets may need to be reconsidered in the context of varying socio-economic contexts from city to city and within any given city.

Here, we first identify and conceptualize how socio-economic factors influence the supply, demand, and benefit of ecosystem services to people in cities. By framing this around the ecosystem service supply chain framework (also known as the ‘ecosystem service cascade’), we distinguish between the biophysical supply of a service, the demand for it, and the benefit it gives people (Potschin and Haines-Young, 2011). In turn, we focus on how socio-economic factors influence the links in the supply chain and illustrate this via three urban ecosystem service/disservice examples: moderation of temperature extremes, urban gardening, and fear and stress reactions. We then outline ways forward for planners and managers to apply this understanding by providing specific suggestions about how to use these concepts and the model to deliver better urban ecosystem service outcomes.

### 2. Linking socio-economic factors to ecosystem services

Our conceptual model distinguishes between the biophysical supply of an ecosystem service, the demand for it by people, and the benefit that people receive from a service that contributes to their well-being (Potschin and Haines-Young, 2011; Tallis et al., 2012; TEEB, 2010; Fig. 1). Urban ecosystems provide biodiversity and ecosystem processes that can potentially provide ecosystem services to people (i.e. ecosystem service supply). Socio-economic factors in cities affect ecosystem services through two distinct and interrelated direct pathways: (1) by influencing the management of urban green space and in turn ecosystem service supply, and (2) by altering human needs and activities and therefore people’s demand for specific ecosystem services. For certain services, there is an (3) indirect pathway whereby a resident’s socio-economic status can influence how the provision of an ecosystem service affects their wellbeing (i.e., their physical or psychological health). Along each of these pathways, ecosystem services can also feed-back to influence socio-economics (e.g., Wolch et al., 2014) although we do not focus on that bidirectionality here. Our model emphasizes the need to understand these multiple pathways through which socio-economic variables influence both the biophysical and social aspects of urban ecosystem service provision (Bagstad et al. 2013).

#### 2.1. Socio-economic factors influence the supply of services

Changes to the amount and characteristics of urban green space affect the presence and abundance of species, the structure of vegetation, the ability of urban residents to access green space, and, subsequently, the ability of urban green spaces to actually supply ecosystem services (Gaston et al., 2013; Caynes et al., 2016). Socio-economic factors influence the ecosystem services supplied by green spaces by altering how much green space is present in cities and how it is managed (Fig. 1). For example, city regulations, zoning

| Categories          | Services                                                                 |
|---------------------|---------------------------------------------------------------------------|
| Provisioning        | Food Supply, Water supply                                                |
| Regulation          | Urban temperature regulation, Noise reduction, Air purification,         |
|                     | Moderation of climate extremes, Runoff mitigation, Waste treatment        |
|                     | Pollination, pest regulation & seed dispersal, Global climate regulation  |
| Cultural            | Recreation, Aesthetic benefits, Cognitive development, Place values & social cohesion |
| Supporting          | Habitat for biodiversity                                                  |
| Disservices         | View blockage, Allergies, Accidents, Fear & Stress, Damages on infrastructure, Habitat competition with humans |
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