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Reaching for a sustainable, resilient urban future using the lens of ecosystem services

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ABSTRACT

Based on recent research on erosion of ecosystem services, planetary boundaries and predicted pace of urbanization, it is now apparent that humans need to reconnect to the biosphere and that cities in this context, properly managed, could provide great opportunities and arenas for social ecological change and transformation towards sustainability To take advantage of these opportunities one needs to keep in mind that most of the ecosystem services consumed in cities are generated by ecosystems located outside of the cities themselves, not seldom half a world away. In order to operationalize our knowledge, hypothesis and theories on the connections between the work of nature and the welfare and survival of humans over time, we suggest the use of the ecosystem service framework in combination with the merging of the concept "ecology *in* cities", mainly focusing on designing energy efficient building, sustainable logistics and providing inhabitants with healthy and functioning green urban environments, and the "ecology *of* cities". The "ecology *of* cities" framework acknowledges the total dependence of cities on the surrounding landscape and the ever-ongoing dance between urban and rural, viewing the city as an ecosystem.

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1. Introduction

The view of people and nature being interlinked and part of the same system, a social ecological system, is not new, but has been lost in the process of increasing our intra-disciplinary depth of knowledge, only to reappear as the absolutely essential framework within which the cure to our contemporary predicament can be found. In order to operationalize our knowledge, hypothesis and theories on the connections between the work of nature and the welfare and survival of humans, we need a concept that will help us clarify and quantify those links and their effects. It is in this framework that the ecosystem service concept becomes useful. The origin of modern concern for ecosystem services can be said to date back to 1864 with the publication of George P. Marsh's book "Man and Nature", in which several ecosystem services are recognized. Expanding on the list of services described in the Study of Critical Environmental Problem report (SCEP, 1970), Holdren and Ehrlich (1974) more or less completed the list of services normally cited and the terms "public services of the global ecosystem" (Ehrlich et al., 1977) and "nature's services" (Westman, 1977) paved the way for the introduction of the term "ecosystem services" (Ehrlich and Ehrlich, 1981). The realization had dawned that seemingly disparate events in the economic, environmental, and political spheres are interconnected.

The general definition of ecosystem services is: "Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life" (Daily, 1997).

1.1. Different Classifications of Ecosystem Services

After the establishment of ecosystem services as a recognizable field of study several classification and accounting schemes were generated. de Groot et al. (2002) e.g. observed the scattered state of the increasing amount of information on the ecological and socio-economic value of goods and services and the difficulties of comparative ecological economic analysis due to a lack of a standardized framework for the assessment of ecosystem functions, goods and services. To meet these difficulties a general classification was provided by grouping ecosystem services into four main categories:

(1) Regulation functions e.g. prevention of soil erosion, storage and recycling of nutrients, purification of air and water, generation of top soils, maintenance of biological diversity and regulation of the chemical composition of the atmosphere. These types of function help maintain the delicate balance of the earth's biosphere, our life support system.
(2) Habitat functions provide space and a substrate for e.g. cultivation, recreation and tourism.
(3) Production functions provide resources e.g. oxygen, water, food, medicines, fertilizers and energy.

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(4) Information functions provide opportunities for e.g. esthetic and cultural enrichment, recreation, research and education.

This classification later partly provided the basis for the Millennium Ecosystem Assessment classification (Millennium Ecosystem Assessment, 2005). The MA distinguishes four different classes of ecosystem services:

1) Provisioning services, the products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.
2) Regulating services, the benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.
3) Supporting services, those are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.
4) Cultural services, the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and esthetic experience as well as knowledge systems, social relations, and esthetic values.

Still, as pointed out by Boyd and Banzhaf (2007) and Wallace (2007), the classification of ecosystem services presented by the Millennium Ecosystem Assessment does not work well for guiding practical accounting exercise or landscape management, respectively. Wallace (2007) suggests a framework utilizing the terms intermediate and final services and benefits, while Fisher and Turner (2008) drawing largely on Boyd and Banzhaf (2007), propose a slightly different definition.

For the purpose of this introduction however, which focuses on illuminating the connections between the work of nature and the underpinning of welfare and survival of humans in a sustainable urban context, the Millennium Ecosystem Assessment definition will suffice. The fact that there are different definitions of the ES concept needs not be worrisome in itself. In fact it could be seen as a health sign that the concept is very much alive and is being scrutinized and developed to better fit the wide range of complex and different situations where it can be useful (Costanza, 2008). It is however crucial to be clear about which definition is being used and the advantages and limitations of a particular definition.

2. Reaching for Sustainability by Combining Ecology *of* and Ecology *in* Cities

Based on several recent reports (e.g. Folke et al., 2011; Millennium Ecosystem Assessment, 2005; Rockström et al., 2009) it is now apparent that humans need to reconnect to the biosphere and that cities in this context, properly managed, could provide great opportunities and arenas for social–ecological change and transformation towards sustainability (see e.g. UNESCO, 2011). To take advantage of these opportunities one needs to keep in mind that most of the ecosystem services consumed in cities are generated by ecosystems located outside of the cities themselves, not seldom half a world away (Deutsch and Folke, 2005). Folke et al. (1997) e.g. already estimated that the 29 largest cities in the Baltic Sea Drainage Basin, taking only the most basic ecosystem services like food production and assimilation of nitrogen and carbon into account, appropriate ecosystem areas equivalent to the size of the entire drainage basin. Thus, as urbanites, we need to concern ourselves not only with what is sometimes referred to as "the ecology *in* cities", mainly focusing on designing energy efficient building, sustainable logistics and providing inhabitants with healthy and functioning green urban environments, but also focus on "the ecology *of* cities". This framework acknowledges the total dependence of cities on the surrounding landscape, viewing the city as an ecosystem (Grimm et al., 2000, 2008). It is thus motivated to concern ourselves with both the generation potential of ecosystem services by ecosystem within as well as outside cities to most effectively manage the potential of cities as arenas for learning, development and transformation.

3. The Role of Biodiversity for Sustainable Ecosystem Service Generation

There is a growing concern about the consequences of biodiversity loss for the provisioning of ecosystem services and it has been clearly shown that biodiversity does indeed have positive effects on many ecosystem services (Balvanera et al., 2006; Díaz et al., 2005).

We are dependent on the interactions of this complex web for providing us with the essentials such as clean air, water, food, shelter, a sense of place, experiences of beauty, serenity and meaning (Millennium Ecosystem Assessment, 2005). There is also increasing scientific evidence on the essential role of biodiversity for building resilience in a changing world (see e.g. Jansson and Polasky, 2010; Elmqvist et al., 2003; Rockström et al., 2009).

Although mass extinctions, granted, have not wiped out all life, they do change the settings for who the "winners" will be in the next round. So the primary concern here is not whether this 6th extinction, referred to as the Holocene extinction (Chapin et al., 2000a, 2000b), which we find ourselves in, will deprive the Earth of all life, which is highly unlikely, but rather how well the planet will be able to provide for *our* species, *Homo sapiens*, in the future.

So, does this mean that we have no way of influencing our situation? Certainly not! But it will require cooperation and coordination of people and knowledge at a scale unprecedented in human history. A fundamental step in the right direction was taken on the 11th of June 2010 in the South Korean port city of Busan, when governments gave the green light to an Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES). The independent platform will in many ways mirror the Intergovernmental Panel on Climate Change (IPCC), which has assisted in catalyzing world-wide understanding and governmental action on global warming. The new body will hopefully help bridge the gulf between the wealth of scientific knowledge, documenting accelerating declines and degradation of the natural world and the decisive government action required to reverse these damaging trends. The ecosystem service approach taken by the platform warrants an anthropocentric focus with the welfare and survival of humans at its core. Also, the 10th conference of the parties (COP) of the CBD (Convention of Biodiversity), held in Nagoya, Japan this year prompted the CBD to develop a new plan of action supported by 20 "SMART" targets for 2020 (Perrings et al., 2010). These targets will be evaluated on the basis of the ecosystem service framework developed by the Millennium Ecosystem Assessment (2005). The previous lack of such coordination and cooperation can at least partly explain why, despite its essential role, biodiversity only fairly recently became a growing part of ecological research and even later in economic research.

4. Scientific Basis for the Connection between Biodiversity and Ecosystem Services in an *Urban Context*

Through the presentation of the following list of ecosystem service I try to illustrate the dependence of city inhabitants on functioning ecosystems and the connections to biodiversity in an urban context, whether these systems are located within the boundaries of the city or not. The list is far from extensive, but will hopefully shed some light on the essential links between biodiversity, ecosystem service generation, human welfare and sustainable urban development in a resource appropriation context. To emphasize the importance of including ecosystem services generated both within and outside the urban area for building urban sustainability and resilience, an ecology *of*/ecology *in* cities distinction is also made.

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