The Potential of Urban Ecosystem Services Valuation as a Tool for Planning More Sustainable Cities

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Abstract | Given the accelerating rate of urbanization worldwide, negative externalities have emerged. This awareness has led to rising demands of political and stakeholder communities to more comprehensively assess impacts of urban development projects on urban landscapes. The Ecosystem Services Valuation (ESV) is relatively a new approach which describes in the scholarly written literature as a good way to provide decision-makers with better choices in their decisions for sustainable city planning. This article explores the potential of urban ecosystem services for improving planning of urban development projects to reach more sustainable cities. First, important ecosystem services in urban areas are classified. Second, the study explores influential literature and their notions in the context of (ESV). Finally, the article analyzes how the ecosystem services valuation may inform urban planning. From the following review, it could be found that many urban ecosystem services have already been identified, characterized and valued. Also, they play a critical role in the human well-being and urban resiliency.

Keywords | Urban Ecosystem Services, Assessment, Urban Planning, Landscape.

Introduction| Most people today live in cities and urbanization is a mega trend that is expected to continue throughout the world at least until mid-century (UN Habitat, 2006). Urbanization has been characterized as "a massive, unplanned experiment in landscape change" leading to the significant conversion of land to urban development. It is predicted that the developing world, especially in Africa and Asia will experience the majority of 21st-century urbanization (Cohen 2006). This future urbanization is unprecedented and emphasizes the need for innovative approaches to generating knowledge before, during and after the process of urbanization in an adaptive mode. Urban ecosystems provide vital services for urban dwellers (McDonald & Marcotullio, 2011). It is implied by scholars that the ecosystem services valuation can help land-use planners to manage areas more comprehensively. Therefore, a better understanding of the linkage between urbanization processes, socioeconomic factors, and ecosystem functions or services is needed to estimate more accurately current and expected impacts of urban growth on human well-being (Bastian et al. 2012); On the other hand ecosystem services are not adequately accounted for in the economy. They are often undervalued, directly or implicitly, sometimes not even accounted for at all. This leads to poor use of resources. Environmental degradation, biodiversity loss and, climate change are all examples of this.

The objective of this paper is to first classify important ecosystem services (ES) in urban areas. Second, a range of influential literature and their notions are described in the context of ecosystem services valuation. Finally, it is concluded that how ecosystem service assessment may inform urban planning and governance processes.

Methodology

This paper aims to analyze how ecosystem services valuation may inform urban planning. The research approach is based on qualitative content analysis method which is lied under interpretive research strategies (Deming and Swaffield, 2011). To achieve this, research was conducted using a systematic review of literature consisting major related books and existing scholarly papers, reports and academic discussions as well as UN reports and agendas. They represent conceptual frameworks and theoretical approaches.

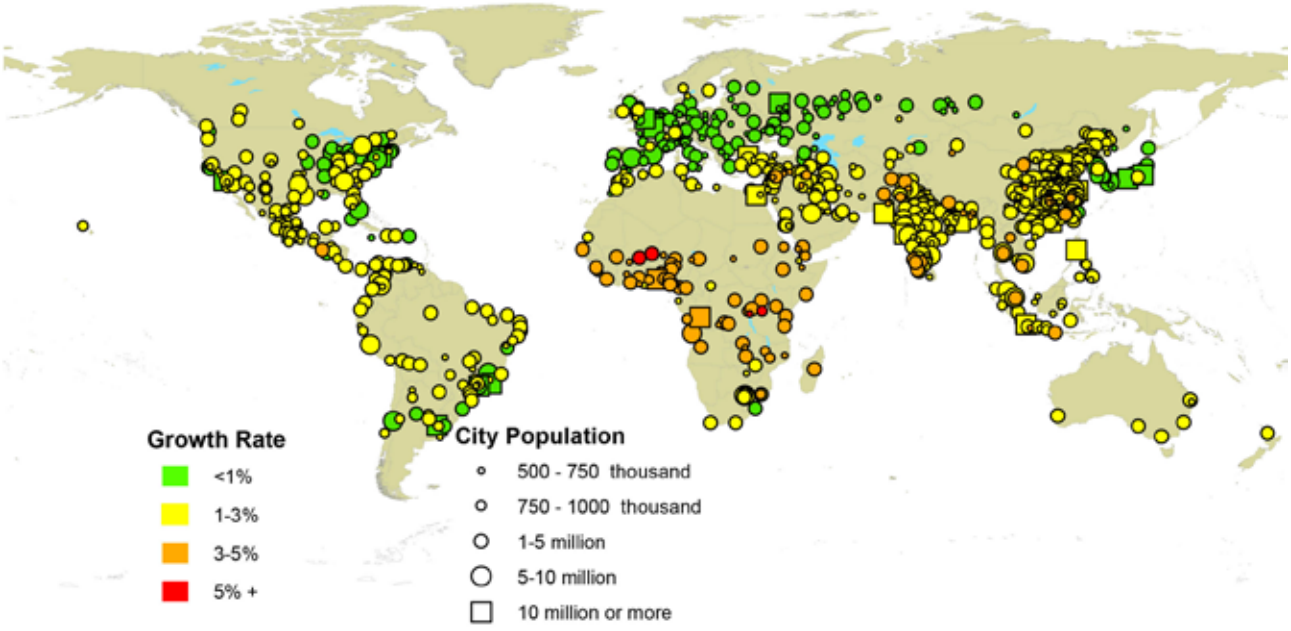
Ecosystem Services

The term ecosystem service has many definitions. The UN Millennium Ecosystem Assessment (MEA) defines it as "the benefits people obtain from ecosystems" (UNEP, 2005:55). Economics of Ecosystems and Biodiversity (TEEB) initiative defines it as "the ecosystems direct and indirect contribution to human welfare". (TEEB, 2010) In a paper criticizing its use, Fisher and Turner defined them as "… the aspects of ecosystems utilized (actively or passively) to produce human well-being" (Fisher & Turner, 2008:1168). All of the definitions relate to how nature is of value to humans. It is an anthropocentric concept. Ecosystems are often very complex and interdependent with all the different components interacting and affecting each other. The theoretical framework is a way of conceptualizing these complex processes (TEEB, 2010).

Background of the term of ecosystem services in Europe and United States

Our planet is increasingly getting urbanized: over half of world's population now lives in cities, and by 2050 that fraction will have increased to 66% according to United Nations prospects. These prospects estimate that continuing population growth and urbanization will add 2.5 billion people to world's urban population by 2050, an increase mostly concentrated in Asia and Africa (UN, 2015; see Pic1). Cities are major hubs for economic and job opportunities and centralize many basic services such as healthcare or education. Cities have disproportionate environmental impacts well beyond their borders, affecting ecosystems at the local, regional, and global scales (Grimm et al., 2008). Cities and their surrounding metropolitan areas often require vast areas of functioning ecosystems to fulfill their consumption, e.g., food, fresh water, construction materials and waste assimilation needs. This ecosystem appropriation by cities is often assessed through the ecological footprint concept (Folke et al., 1997) or the ecology of cities framework (Jansson, 2013). These approaches acknowledge the exceeding dependence of cities on their hinterland (and beyond) and the links between urban and rural, viewing the city as an ecosystem itself (Grimm et al., 2008). Concurrently, urban areas are also facing pressing challenges within their borders. Pollution and other disturbances generated in cities have also direct and sometimes dramatic health impacts on the urban population (WHO, 2014).

Improving sustainability, resiliency, and livability in cities should, therefore, be a major goal on any governments agenda, from local to global authorities. At a global scale, for example, one of the seventeen United Nations Sustainable Development Goals are to "make cities inclusive, safe, resilient and sustainable". In the European Union, these strategies relying on urban ecosystems and their processes are mostly built on the concepts of "green infrastructure" (GI, see EC, 2013) and, more recently, NbS "nature-based solutions" (see EC, 2015). Both terms are very much related as reflected in the EU GI strategy, which defines GI as "a successfully tested tool for providing ecological, economic and social benefits through natural solutions". It is believed that GI is based on the principle that "the many benefits human society gets from nature, are consciously integrated into spatial planning and territorial development" (EC, 2013:2 see also Section 1.3.2). Since the seminal works of de Groot (1992), Daily (1997) and Costanza, et al. (1997), research on ES has grown significantly. The Millennium Ecosystem Assessment (MEA, 2005), the



Pic 1: Growth rates of urban agglomerations by size class (prospect 2030 – 2014). Source: (UN, 2015).

Economics of Ecosystems and Biodiversity global initiative (TEEB, 2010) and the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) have brought the concept into broader planning and policy arenas. In relation to ES classification systems is worth mentioning the initiative for a Common International Classification of Ecosystem Services (CICES).

Attention paid to urban areas in the ES literature was initially modest as compared to other ecosystems located in more rural or natural landscapes (see MEA, 2005). This disregard for ES of urban areas has changed over recent years. Since the seminal paper by Bolund and Hunhammar (1999), a growing body of literature has advanced our understanding of urban ES in their spatial, temporal, value or practical dimensions (Gómez-Baggethun et al. 2013; Haase et al., 2014). Also, Gómez-Baggethun and Barton (2013) synthesized knowledge and methods to classify, assess and value urban ES for planning, management, and decision-making. Urban ES such as air purification, noise reduction, urban temperature regulation or runoff mitigation, not explicitly considered in MEA (2005) and TEEB (2010) classifications, were highlighted in that work due to their expected relevance for the quality-of-life of the urban population. This Article largely follows the terminology used in this classification of urban ES (see also Gómez-Baggethun et al., 2013) (Table 1).

The book Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities (Elmqvist et al., 2013), an output of the Cities and Biodiversity Outlook (CBO) project, identified at least four knowledge gaps related to urbanization and ES research. First, there is a geographical gap, since most scientific studies of urban ES are undertaken in Europe, North America and China (see also Haase et al., 2014; Luederitz et al., 2015). Second, there is also a valuation gap because non-monetary (e.g., socio-cultural) values of urban ES are still not considered on an equal basis with monetary values in decision-making processes (Gómez-Baggethun and Barton, 2013). Further, methods to approach insurance values, i.e., the value of ES and biodiversity in reducing urban vulnerability to shocks and disturbance from a resilience perspective, are still poorly developed (TEEB, 2010). Gómez-Baggethun et al. (2013) argue that despite their important role in cities, cultural ES provided by urban ecosystems are still under-researched relative to other categories such as regulating ES (e.g., Haase et al., 2014; Langemeyer et al., 2015). Finally, so-called supply-demand gap exists because there is an increasing body of knowledge on the provision of ES (supply side) at different scales, but there is little information on needs, preferences and policy targets on ES (demand side) in urban areas, and whether or not these demands match the capacity of urban ecosystems to deliver ES (Haase et al., 2014).

Classification of Urban Ecosystem Services

Generally, ES are classified into four main categories: provisioning, regulating, cultural and supporting or habitat ser-

Table 1: The chronology of useful notions in the context of operationalizing the ecosystem services (ES) framework since 1992 which provides a powerful way of examining the interaction between ecosystems and human well-being. Source: Authors, 2017.

influential scholars and movements	year	notion
United Nations Conference on Environment and Development (the Earth Summit in Rio de Janeiro)	1992	Moved the ecosystem services concept from the academic field to the political realm (Gómez-Baggethun and Ruiz-Pérez, 2011).
Convention on Biological Diversity (CBD) agreement	1992	The CBD recommends land-use managers to focus on sustainable and equitable management of land, water, and living resources (Forkink, 2015).
de Groot	1992-2010	In the Netherlands de Groot and colleagues (2010) developed a conceptual framework for integrated ecosystem services assessment to facilitate the integration of ESA into land-use planning. This framework builds on earlier publications (de Groot et al., 2010).
Costanza et al.	1997	In this article, various scholars attempted to estimate "the economic value of 17 ecosystem services for 16 biomes" and the value of the entire biosphere in order to show the importance of ecosystem services for human well-being (Costanza et al., 1997: 257).
Daily and colleagues	1997-2009	Emphasize the importance of collaboration with stakeholders, predicting future conditions, assessing current conditions, and long-term monitoring of natural systems.
Bolund and Hunhammar	1999	They tried to "identify, and whenever possible also quantify and value, the ecosystem services generated in urban areas" (Bolund and Hunhammar, 1999).
Millennium Ecosystem Assessment	2000	The main purpose of the MA report is to improve ecosystem management and human well-being on a global scale (MEA, 2005).
The National Research Council (NRC) published the report "Valuing Ecosystem Services: Toward Better Environmental Decision-Making" (NRC, 2005).	2005	NRC promotes interdisciplinary collaboration between ecologists and economists (NRC, 2005).
The Economic Ecosystem Benefits (TEEB)	2007	The purpose of the TEEB approach is to "help decision-makers to determine the best use of scarce ecological resources at all levels" by providing a common language and an economic assessment of ecosystems and biodiversity (TEEB, 2010: 24).
DEFRA (Department for Environment, Food & Rural Affairs)	2007	DEFRA's most current approach includes a set of principles that relate to communication, stakeholder engagement and ecosystem functioning (DEFRA 2013; 2013).
Cities and Biodiversity Outlook (CBO) project (See http://www.cbobook.org)	2010-onwards	(CBO) is the world's first global analysis of how projected patterns of urban land expansion will impact biodiversity and crucial ecosystems.
Nahlik and colleagues	2012	Compared 11 ESA frameworks based on six evaluation criteria. These criteria were related to the level of 1) use of ecosystem services definition and classification system, 2) trans-disciplinary collaboration, 3) community engagement, 4) incorporation of resiliency concepts and adaptive strategies, 5) cohesiveness and coherence, and 5) policy relevance (Nahlik et al., 2012).
The Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES)	2012	Have brought the concept into broader planning and policy arenas.
Common International Classification of Ecosystem Services (CICES)	2016	CICES is complementary to MEA and TEEB classifications and aims to provide a systematic standardization of ES in the context of environmental accounting, mapping, and valuation (See http://cices.eu/)
Gómez-Baggethun and Barton	2013	Gómez-Baggethun and Barton (2013) synthesized knowledge and methods to classify, assess and value urban ES for planning, management, and decision-making.
The book Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities	2013	Identified at least four knowledge gaps related to urbanization and ES research (Elmqvist et al. (eds.), 2013).
EU GI (green infrastructure) and NbS (nature-based solution)	2013-2015	Both terms are very much related. The EU GI strategy defines GI as "a successfully tested tool for providing ecological, economic and social benefits through natural solutions" and states that GI is based on the principle that "the many benefits human society gets from nature, are consciously integrated into spatial planning and territorial development" (EC, 2013:2).

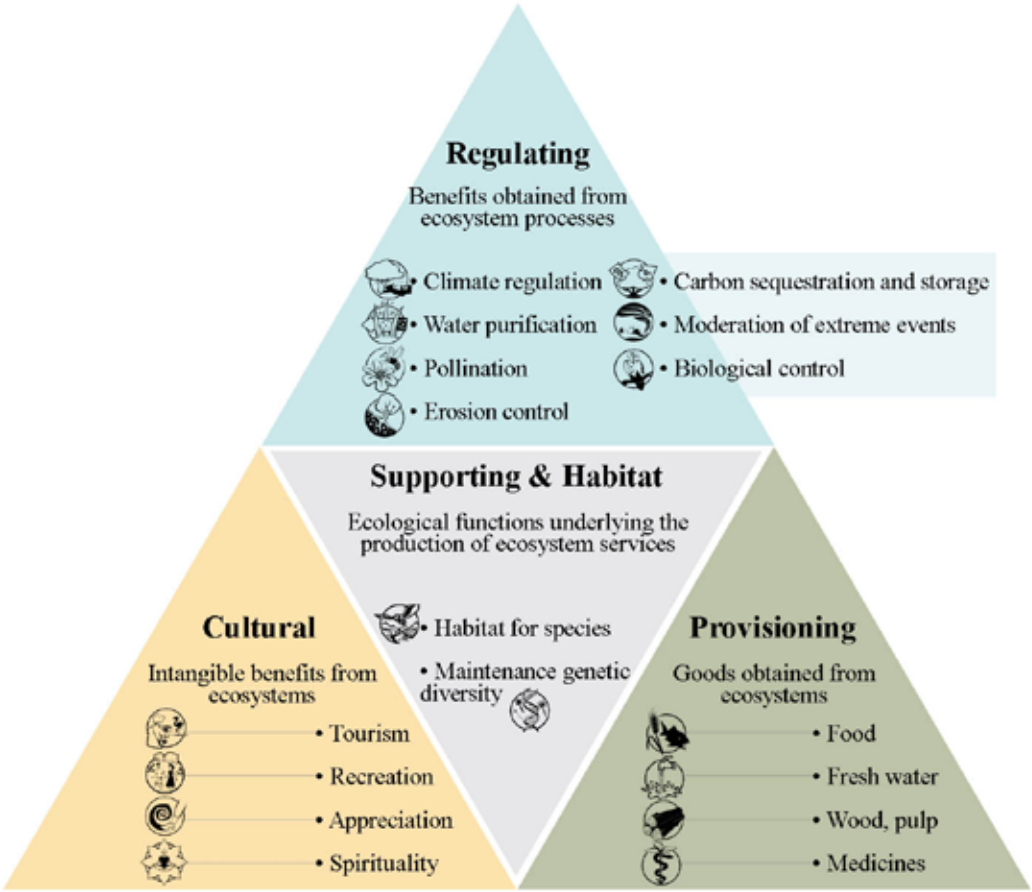
vices (MEA, 2005; TEEB, 2010). These benefits are obtained from various ecosystem components and processes that are directly or indirectly beneficial to humans (MEA, 2005). Provisioning ES includes all the material goods obtained from ecosystems, such as food, fiber, fresh water or medicinal resources. Regulating ES includes all the ways in which ecosystems can mediate or moderate the ambient environment, including climate regulation, moderation of extreme events, erosion prevention or biological control. Cultural ES is the non-material outputs of ecosystems that affects physical and mental states of people, for example through spiritual experience, recreation, aesthetic appreciation or sense of place. Finally, supporting or habitat ES defines as the ecological processes and functions that are necessary for the production of the previous "final or end ES," including habitat for species and maintenance of genetic diversity (Pic 2).

Over the past decade, the concept of ES has been successfully mobilized as a "pedagogic tool" or "communication metaphor" which supports ecosystem and biodiversity conservation (Liu et al., 2008; Gómez-Baggethun et al., 2010). The approach is also widely used as a framework to understand and analyze the relationships between society and nature. Below a classification and description of important ecosystem services provided in urban areas is shown using the Millennium Ecosystem Assessment and the TEEB initiative as major classification frameworks, and drawing on previous research on the topic (e.g., Bolund and Hunhammar 1999; Gómez-Baggethun and Barton 2013); (Table 2)

Ecosystem Services in Urban Planning and Design

In order to turn ecosystem services as an assessment tool into a practical instrument for planning and design, a better understanding of ecosystem services, their spatial characteristics and interrelations are excessively needed (Troy and Wilson, 2006). Research in ecosystem services is gradually integrating with landscape ecology and spatial planning addressing the issue of the scales and structures related to the generation and application of ecosystem service.

Limited integration could be seen in ecosystem services and urban planning and design. First, because the model was originally designed for non-urban landscapes, principally by natural scientists, and as such is not well-suited to the built



Pic 2: Classification of ecosystem services based on the Millennium Ecosystem Assessment (MA 2005) and the Economics of Ecosystems and Biodiversity initiative (TEEB 2012). (Produced by Authors with icons from http://www.teebweb.org/resources/ecosystem-services/)

Table 2: Classification of important ecosystem services in urban areas and underlying ecosystem components. Source: (Gómez-Baggethun and Barton 2013) with some changes.

Major categories of ecosystem services	Ecosystem Services	Example	Major references
provisioning services	Food Supply	Vegetables produced by urban allotments and peri-urban areas	Ahern et al. (2014); Lauf et al. (2014)
	Energy Supply	Renewable and decentralized energy	
Regulating Services	Urban Temperature Regulation	Trees and other urban vegetation provide shade, create humidity and block the wind	Bolund and Hunhammar (1999)
	Noise Reduction	Absorption of sound waves by vegetation barriers, especially thick vegetation	Aylor (1972)
	Air Purification	Absorption of pollutants by urban vegetation in leaves, stems, and roots	Jim and Chen (2009); Escobedo et al. (2011)
	Moderation of Climate Extremes	Storm, flood, and wave buffering by vegetation barriers; heat absorption during severe heat waves; intact wetland areas buffer river flooding	Danielsen et al. (2005)
	Runoff Mitigation	Soil and vegetation percolate water during heavy and/or prolonged precipitation events	Villarreal and Bengtsson (2005)
	Waste Treatment	Effluent filtering and nutrient fixation by urban wetlands	Vauramo and Setälä (2011)
	Pollination, Pest Regulation, and Seed Dispersal	Urban ecosystem provides habitat for birds, insects, and pollinators	Andersson et al. (2007)
	Global Climate Regulation	Carbon sequestration and storage by the biomass of urban shrubs and trees	McPherson (1998)
Cultural Services	Recreational and Ecotourism	Urban green areas provide opportunities for recreation, meditation, and relaxation; "forest recreation", "recreational fisheries", "leisure activities"	Chiesura (2004); La Rosa et al. (2016)
	Aesthetic Values	Urban parks in sight from houses; "Landscape Aesthetic"; "Scenic Quality"	Tyrväinen (1997); La Rosa et al. (2016)
	Cognitive Development	Allotment gardening as preservation of socio-ecological knowledge	Barthel et al. (2010);
Habitat Services	Habitat for Biodiversity	Urban green spaces provide habitat for birds and other animals that people like watching	Ahern et al. (2014)

environment. Research that has explicitly studied ecosystem services in cities focus on ecological processes in the city, rather than of the city (Collins et al. 2000; e.g. Bolund and Hunhammer, 1999). The second concern is that the ecosystem services framework lacks balanced geographic, contextual, and spatial considerations. The third limitation stems from the ideological strain between and within urban planning and ecological discourses. This tension is seemingly exhausted in the debate over the ecological value of novel ecosystems, or landscapes that have been "heavily influenced by humans" (Marris, 2009: 450). Some scholars praise the ecological potential and importance of these landscapes, while others consider them "ecological disasters, where biodiversity has been decimated, and ecosystem functions are in tatters" (Marris, 2009: 452). The final major limitation to the successful integration is the absence of accessible, balanced tools and standards for implementation (Tzoulas et al., 2007). Urban scholars have highlighted the need for a planning approach that synthesizes and balances the trade-offs of multiple biophysical and socio-economic perspectives across multiple spatial scales and also details, "how different land uses can be configured for greater support of biodiversity and ecosystem services" (Colding, 2007: 46). Further, they argue, such a tool can only be effectively and efficiently mobilized by urban planners and designers (Gutman, 2007).

Valuing Ecosystem Services in Urban Areas

Value is defined as the relative worth, merit or importance of something. What we mean by value is not universally understood. When talking about natural capital we can measure biophysical, socio-cultural, health, justice and insurance values. The neoclassical economic system has created massive externalities. There is a pervasive market failure to take nature sufficiently into account. Ecological scarcities, ecosystem degradation, biodiversity loss and climate change are the results (Costanza et al., 1997). Valuing urban ecosystem services is a good way of making these values explicit to the decision makers, and put them in a better position to make good choices about city planning (Gómez-Baggethun & Barton, 2013). We are in a better position to make good choices about trade-offs between the environment and other concerns by making the values clear to the decision-makers.

One of the most influential early papers on urban ecosystem services was written by Bolund and Hunhammar in 1999. They identify seven ecosystems and six ecosystem services in urban areas and stress that ecosystem services have a large impact on quality of life in urban areas (Bolund & Hunhammar, 1999). Geoffrey Heal cleared a discussion on value and prices also presented the methods for valuing ecosystem services. His paper stressed the shortcomings of the methods and claimed that valuation is neither necessary nor sufficient for conservation. Rather economics should help design institutions that provide incentives for the conservation of important natural systems and make humans impacts on biosphere sustainable (Heal, 2000). The large potential of valuation has pointed by Daily and others and they made the point that valuation happens implicitly in the economy and that this is not sufficient (Daily et al., 2000). Many scholars have called for a trans-disciplinary approach to valuing ecosystem services as presented in the paper by Liu, Costanza, Farber, and Troy in 2010. This synthesis of literature describes the history, use, and future of valuing ecosystem services (Liu et al., 2010). Most cities consume ecosystem services from areas many times the size of the actual city. This consumption is often inefficient and unsustainable. Gómez-Baggethun and David Barton, they argue that "Conserving and restoring ecosystem services in urban areas can reduce the ecological footprints and the ecological debts of cities while enhancing resilience, health, and quality of life for their inhabitants" (Gómez-Baggethun & Barton, 2013); (Table 3).

Conclusion

Despite usefulness of urban ecosystem services (UES) for urban planning, findings of this review reveals that studies with focus on UES are still limited. It could be concluded that the lack of both historic and future-oriented research is apparent. A majority of studies on UES has been undertaken in the United States and Europe. Thus it is necessary to develop the UES research to other continents. A variety of perspectives are seen in doing UES studies between years (1992-2012). Whereas many perspectives encompassed ecology, methods, economic, social in relation to planning found during 2010-2015 researches. They are mostly concerned with regards to studies of UES classification, provisioning, regulating and cultural ecosystem services. It should be noticed that, even when diverse UES were considered, trade-offs among these services were not examined. Future research award informing urban planning by UES should be developed on process understanding, a framework to integrate UES with economic aspects, the application of multi-criteria evaluation as a tool into the UES approach.

Also, the competing alternative uses, worsening conditions and rising costs of provisions in urban areas, means green structures have to be protected and conserved. Valuing urban ecosystem services is a good way of making these values explicit to the decision makers, and put them in a better position to make good choices in their city planning process and implementation.

Table 3: Influential literature and their notions in the context of ecosystem services (ES) Valuation.

Influential scholars	Year	Publication	Notion
Bolund and Hunhammar	1999	Ecosystem services in urban areas	They claim that urban ecosystem services can help tackle problems locally and efficiently (Bolund & Hunhammar, 1999).
Geoffrey Heal	2000	Valuing ecosystem services	cleared a discussion on value and prices also presented the methods for valuing ecosystem services (Heal, 2000).
Daily and others	2000	The value of nature and the nature of value	They stress the importance as well as formulate principles for valuation.
Farber, Costanza, & Wilson	2002	Economic and ecological concepts for valuing ecosystem services	covers the issues of ecological thresholds and uncertainty.
Liu, Costanza, Farber and Troy	2010	Valuing ecosystem services	Valuing ecosystem services needs to become more trans-disciplinary and more problem-driven rather than tool driven (Liu, et al., 2010).
Gómez-Baggethun and David Barton	2013	Classifying and valuing ecosystem services for urban planning	They go on to present knowledge and methods for classifying and valuing ecosystem services for urban planning, including different valuation languages and dimensions as well as analytical challenges.

Endnote

*.This paper is part of an ongoing PhD research titled "Investigation of Effective Landscape parameters for Application in Sustainable Urban Landscape Planning". The research is undertaken by the second author, with the supervision of the first author at "NAZAR Research Center for Art, Architecture, and Urbanism", Tehran-Iran.

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