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Ecosystem services: A bridging concept of ecology and economics

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Abstract. Nature is bountiful to all living organisms on Earth including human beings. Human, throughout the life, obtained various benefits from ecosystem for the sustenance on planet Earth. Ecosystem service is a linking concept between ecology and economics recently paying attention worldwide. Economic and social development critically depends on the natural capital although at the environmental cost but need bridging of nature components. In the current scenario, due to increasing anthropogenic interferences ecosystem is under great threat. It is time to include ecosystem services agenda in the framework of policy to human and sustainable development.

Key words: Ecosystem services, Human well-being, Natural capital, Social capital, Sustainable development.

1. Introduction

Ecosystem services are the benefits that people obtain from ecosystem (MA, 2003, 2005). Ecosystem services reveal the inherent role of nature to human being. A very good understanding about the linkages between the natural and socio-economic systems can result in enriched and sustainable management of natural resources and ecosystem services (Guerry et al., 2015; Grizzetti et al., 2016). Ecosystem service concept functions as the bridge between natural world i.e. ecology and human world i.e. economics (Bratt & Groot, 2012). The main goal of the Millennium Ecosystem Assessment (2005) was to assess the consequences of ecosystem changes for human well-being. In last 50 years human have altered ecosystem more abruptly than in any comparable period of time in human history (MA, 2005). Millennium Ecosystem Assessment (2005), a herculean task to assess the status of ecosystem and its services highlighted various issues regarding the ecosystem. According to MA 2005, globally 15 out of 24 ecosystem services are in a state of declining (MA, 2005; Fisher et al., 2009).

A comprehensive assessment of the benefits we get from a particular ecosystem is increasingly needed to restore and maintain that ecosystem for sustainable development policy (Heal, 2000; Kramer, 2007; Jenkins et al., 2010). Assessment of ecosystem goods and services is an urgent need to both local people and policy makers (van Oort et al., 2015). The main objective of this article is to present an overview of ecosystem service and its related concepts.

2. Ecosystem services: a historical account

Ecosystem, a term that is often used interchangeably with nature. Ecosystem is a system of biotic and abiotic components interacting in a way that sustains the life on earth. When we talk about nature, we mean everything that exist in the universe like plants, animals, stars, galaxy, earth, moon, sun, bacteria, viruses, elephants, mountain, rivers, ocean, flowers, and air. The list is endless. Although the term ecosystem services is new the concept is as old as

human history and traces back to the time when our ancestors were completely dependent on their surrounding (Daily, 1997). Humans have hampered the ecosystem for millennia though obtaining various tangible and intangible products for their welfare. For centuries we have been getting various services from ecosystem in terms of materials like food, fiber, medicines, timber, freshwater and intangible services like inspiration, tourism, water purification, carbon sequestration. Husbandry and agriculture are among the oldest attempts of human to utilizing ecosystem services in through a proper management (Fisher et al., 2009). Therefore, ecosystem has been an integral to our life since time immemorial. Post green revolution era has been witnessed of several interests of analysis of ecosystem services and including them in policy framework for environmental management and sustainable development (Dominati et al., 2010).

Book "Man and nature" written by Marsh (1864) is one of the breakthroughs in the weakening of American's belief of infinite natural resources in their countries. Marsh was very much aware about the waste disposal service of natural ecosystems. He wrote that "the carnivorous and often the herbivorous render an important service to man by consuming dead and decaying animal and vegetable matter, the decomposition of which would otherwise fill the air with effluvia noxious to health" (Marsh, 1864; Daily, 1997; Braat & Groot, 2012). Daily's book "Nature's Services: Societal Dependence on Natural Ecosystems" is a great source the concept of ecosystem services (Daily, 1997). An MIT Study of Critical Environmental Problems (SCEP, 1970) was the first to use the term environmental service (Wilson & Matthews, 1970). In SCEP (1970) report, insect pollination, fisheries, climate regulation and flood control were listed as environmental services. The term ecosystem service is coined by Paul and Anne Ehrlich in 1981 (Braat & de Groot, 2012). The scientific research paper by Costanza et al. (1997) on "the value of the world's ecosystem services and natural" became a milestone in the economic valuation of ecosystem services. This paper torched the economic value of world's natural assets in terms of money. The result presented by Costanza et al. (1997) helped in the development of various monetary valuation methods and studies worldwide. Since the publication of Millennium Ecosystem Assessment (2005) report, the concept of ecosystem services has gained mounting attention among policy makers, conservationists and scientists across the world. This assessment highlighted that most of the ecosystem services are in declining due to human induced ecosystem changes (MA, 2005).

3. Concept of ecosystem services

The term "service" is used in economics as intangible commodity. Communities get benefits from ecosystem in many ways to sustain their life. In context of ecosystem services concept both ecosystem products and services are known by a single term "ecosystem services". In general various products and services which human obtained from ecosystem called as ecosystem services. There are several definitions to define the concept of ecosystem services and many are still evolving. One of the most common definitions given by Millennium Ecosystem Assessment is "the benefits people obtain from the ecosystems" (MA, 2005). Some alternative definitions of ecosystem services are given in the Table 1.

Ecosystem services are the benefits derived from ecosystem (MA, 2005). MA 2005 categorized ecosystem ser-

Table 1. Alternative definitions of ecosystem services

Definitions	References
The capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly.	De Groot (1992)
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)
Ecosystem services are the benefits human populations derive, directly and indirectly, from ecosystem functions.	Costanza et al. (1997)
Ecosystem services are the benefits people obtain from ecosystem.	MA (2005)
The benefits of nature to households, communities and economies	Boyd and Banzhaf (2006)
The aspects of ecosystems utilized (actively or passively) to produce human well-being.	Fisher et al. (2009)
Contributions of ecosystem structure and function-in combination with other inputs-to human well-being.	Burkhard et al. (2012)

vices into four major groups i.e. provisioning services, cultural services, regulating services and supporting services. Provisioning services are the goods or products obtained from ecosystems, such as food, timber, medicines, fiber, and freshwater; cultural services are the nonmaterial benefits obtained from ecosystems, such as recreation, spiritual values, and aesthetic enjoyment; regulating services are the benefits obtained from an ecosystem's control of natural processes, such as climate, disease erosion, water flows, and pollination, as well as protection from natural hazards and supporting services are the natural processes that maintain the other ecosystem services, such as nutrient cycling and primary production (MA, 2005).

It is important to note that ecosystem functions or processes become services only when human have been benefited from them. Without human beneficiaries, ecosystem services are just ecosystem functions or ecosystem processes (Fischer at al., 2009). Thus human capital is involved in ecosystem service. According to de Groot et al. (2002), ecosystem services are the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly. Contributions of ecosystem structure and function-in combination with other inputs-to human wellbeing (Burkhard et al., 2012). For example, food production is a provisioning ecosystem service that is based on the primary production that is an ecosystem process. But other inputs like irrigation, seeds, machinery, fertilizers etc. are necessary to convert primary production to food production. Similarly ecotourism is an ecosystem services become as benefit to human being only after human, social and built capital inputs (Boyd & Banzhaf, 2007). Boyd and Banzhaf (2007) criticize the fact that many of the 'services' listed by Daily (1997) or in the Millennium Ecosystem Assessment (MA, 2005) are actually ecosystem processes or functions. Boyd and Banzhaf (2007) introduced the term final ecosystem services which refers to the components of nature directly enjoyed, consumed or used to yield human well-being (Burkhard et al., 2012).

4. Linkages of natural and social capital

Natural capital refers to the biotic and abiotic components of ecosystems-other than people and what they manufacture-that contribute to the valuable goods and services for human welfare and human also affect ecosystem significantly (Guerry et al., 2015; Fig. 1). Ecosystem sustains human through providing a range of ecosystem services and human impacts ecosystem through overexploitation, climate change and pollution. Ecosystem services are the consequences of the flow of matter and energy from natural capital to human welfare (Costanza et al., 1997). An eloquent way to understand the ecosystem value is based significantly on the natural capital and ecosystem service frameworks (Raymond et al., 2009).

Ecosystem service concept is getting increased attention at global level to depict the human dependence on

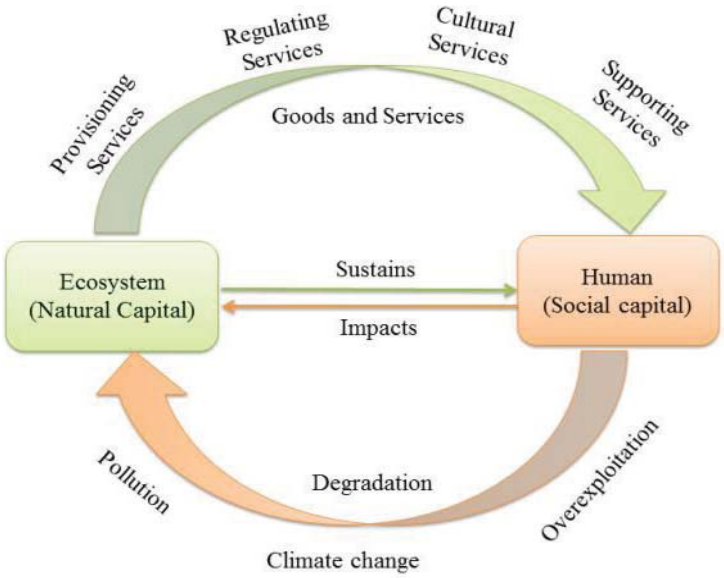

Figure 1. Linkages of natural capital with social capital

nature for its various services. 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). According to McPhearson et al. (2014) "Ecosystem services refer to those ecosystem functions that are used, enjoyed, or consumed by humans, which can range from material goods (such as water, raw materials, and medicinal plants) to various non-market services (such as climate regulation, water purification, carbon sequestration, and flood control)". Ecosystem is provider because it provides services to human being that is known as consumer (Guerry et al., 2015).

Natural resources and ecosystem services are important to the wealth of nations as through tourism, food and manufacturing (Onofri et al., 2017). Costanza et al. (1997) through their work set a millstone in ecosystem services valuation. In 1997 they estimated that the ecosystems provide at least US$ 33 trillion dollars' worth of services annually. A total of 17 ecosystem services were valued and out of these 17 services nutrient cycling is the single largest valued ecosystem service with a value of US$ 17 trillion per year (Costanza et al., 1997). Pollination is an important ecosystem service generally under estimated but it plays a great role in food production. The production of more than 75% of the world's most important crops that feed humanity and about 35% food production is critically depend on animal pollination (Klein et al., 2007; Zhang et al., 2007). Food, fiber, water and shelter are basic needs of humanity that are fulfilled by ecosystem structure and functions. Ecosystem provides a range of services on many levels from local to regional and national to global level based on their use and context (van Oort et al., 2015).

5. Threats to ecosystem services

Land use change is among the major anthropogenic effects on ecosystem and its services (Kaczorowska et al., 2016). In the current scenario, anthropogenic activities are the greatest threat to the ecosystem and its services. With the industrial revolution a new era of Anthropocene has been evolved in with human activities are the main drivers of global environmental degradation like climate change, natural resource loss, biodiversity loss and environmental pollution (Crutzen, 2002; Steffen & Crutzedn, 2007; Rockström et al., 2009). An important facet of environmental degradation is the loss of ecosystem services. Humanity has altered the ecosystem in extensively to obtain desired ecosystem services such as food, fiber and timber (Bennett et al., 2009). Thus human engineered the natural ecosystem to a managed one to maximize ecosystem services. Agriculture is among the largest engineered ecosystem (Zhang et al., 2007). Domestication of animals and plants is among the most important feature of the human domination on planet earth (Kareiva et al., 2007). Cropland and pastures with occupying 40 % of land surface are among the largest terrestrial biomes on earth, surpassing the forest cover (Foley et al., 2005). Management of ecosystem services is very challenging task before policy makers and environmentalists due to their interrelated and integrated nature. The sustainability of one ecosystem service is dependent on the other and the attempts to enhance a single services result to decline or losses of other service or we can say that they are traded-off (Heal et al., 2001; Pereira et al., 2005; Farber et al., 2002; van Jaarsveld et al., 2005; Holling & Meffe, 1996; Rodríguez et al., 2006). For the sustainability of ecosystem services, it is the need of current time to manage ecosystem through improvement in its structure.

6. Significance of ecosystem service assessment

Assessment of ecosystem is become an important subject in scientific era largely due to increasing influences of natural resources degradation and declining ecosystem services (TEEB, 2008; Rounsevell et al., 2010; Cowie et al., 2011; Kalaba et al., 2013). Valuing ecosystem and nature is fundamental to mainstreaming the environmental conservation and management. Ecosystem services provide an approach to bridge the gap between ecology and economics. This approach has contributed to policy framework and environmental management (Chan et al., 2012).

Ecosystem service concept is an effective tool to link the human with nature. It provides a common platform to assess the multiple benefits form ecosystem to every individual in society (Ajwang'Ondiek et al., 2016). Ecosystem service is an anthropocentric concept that is getting a mounting attention as tool to raise awareness at local and global level about the multitude benefits of ecosystem and environmental challenges (MA, 2005; Seppelt et al., 2012; TEEB, 2011; Lauf et al., 2014). Biodiversity is the foundation of ecosystem services on planet earth and its loss is the loss of ecosystem services itself. Due to this reason ecosystem service has gained increased in context of ecological and environmental perspectives. Mapping of natural capital asset and ecosystem service values play a significant role in the local environmental management (Raymond et al., 2009).

7. Conclusion

Ecosystem services are the foundation of economic activities for human well-being. Ecosystems have both fiscal and non-fiscal value. The concept of ecosystem services is getting an increased attention. Natural capital is

the foundation of ecosystem goods and services on earth. For sustainable development, the proper management and utilization of ecosystem services is needed. Proper valuation of ecosystem services of various ecosystems is currently required. Due to lack of economic valuation, ecosystems have become prone to degradation. Human will be sustained if nature and its services are sustained. A linking approach of natural capital with social capital is necessary for human well-being and environmental sustainability.

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