

Ecosystem services- an overview

Dipak Uchampalli¹, E. Girish Kumar², S. Vikrant²

¹Asst. Professor of Economics, Tagore Arts College, Lawspet, Pondicherry-605008, India

²Asst. Professor of Botany, Mahatma Gandhi Government Arts College, Mahe, Pondicherry-673311
girishkzd@gmail.com, dipakuchampalli@gmail.com, dr.s.vikrant@gmail.com

Abstract

Objectives: To elaborate the essence of Ecosystem services to scientists and stake holders and throw some light on to its interrelated disciplinary nature. People of all strata need a thorough understanding of the surrounding ecosystem and the services provided by it to human in various means. A scientific attitude and temper is the need of hour to protect our mother Earth from ailments of pollution and imbalances.

Method: Various aspects of ecosystem services have been reviewed and the basic facts were elaborated thoroughly to grass root level so as to transfer the concept to even novices. Important concepts by scientists of respective fields have been analyzed and portrayed in a systematic manner. Efforts were taken to relate the dependence of common man to ecosystem for his successful survival on this planet.

Findings: The ecosystem services had been classified to mainly 4 types. This paper has described various facets of services in detail. The Provisioning services elaborated here are food, fodder, fuel, fiber, water, biochemical, alginates, ornamental resources and generic resources. Regulating services explained are air, climate, water, nitrogen fixation, disease outbreak, biological control, pollination, storm etc. Cultural services are explained as cultural value, religious value, educational value and aesthetic value. Supporting services of different types are also mentioned in this context.

Applications: The new findings can be applied to assess the ecosystem service values which can support the economy of a country. People should be made aware of the importance of ecosystem services so that they can utilize the products and processes of nature in a sustainable manner.

Key words: Ecosystem, provisioning services, regulating services, cultural services, supporting services.

1. Introduction

Earth is the abode of multitude of species. These organisms are connected by energy needs through their mutual interdependence, though the ultimate source of energy is the Sun. Autotrophs, mainly green plants, are the only group capable of fixing solar energy to chemical energy and store in their cells in the form of organic reserve food.

The trapped solar energy is converted into chemical energy and stored in these foods. The organisms of the environment thrive upon by the process of eating and being eaten which is the modus operandi of transfer of energy. This energy is used for growth and reproduction by organisms which lead to sustenance of biodiversity on Earth. Natural sink of plants for water and CO₂ is soil and air respectively.

They also absorb various nutrients from the soil that support many metabolic activities. Animals get water from soil and O₂ from atmosphere. In this way, all organisms depend upon each other and the surrounding environment for their successful propagation which is the essence of ecological studies.

Plant diversity can enhance below ground zoo diversity and microbial biomass which in turn can control erosion of soil through the effects of root system and mycorrhizal network of the soil [1]. These biotic (living) and a biotic (non-living) factors are the inseparable part of Ecosystem. The organisms depend on their physical environment to accumulate biomass and also to decompose it after death so that the minerals are released back to a biotic system.

This can be well exemplified by the cyclic movement of Water, Carbon dioxide, Nitrogen, Phosphorous, Sulphur etc., which are the intricate factors of biochemical cycling. This mineral cycling is important to stabilize and maintain the volume of nutrients used. Ultimately this leads to a balanced equilibrium which is the core of a sustainable system.

2. Ecosystem services

The advantages and benefits the organisms derive from ecosystem are generally known as ecosystem services. In fact, the process of natural ecosystem and ecosystem services are two sides of the coin, ecosystem. From an anthropological angle, ecosystem services help for successful survival of mankind on this Earth by maintaining biodiversity of micro and macro utilitarian goods and values [2] proposed that "Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem function [3] have mentioned that valuing natural resources is a complex, spatial and institutional cross-scale problem.

This fact points to the difficulty in assessing the value provided by ecosystem services. Ecosystem services of agro-ecosystems have been well documented [4]. In a practical aspect, ecosystem services can be divided into four categories though there may be overlapping of a few. This classification is based on the report by The Millennium Assessment Framework [5]. They are provisioning services, regulating services, Cultural services and Supporting services.

2.1. Provisioning services

Provisioning services include various useful products derived from ecosystem. It includes all services which provide direct benefits to man.

1. **Food:** Ancient man consumed tubers, fruits and seeds of plants and later started hunting animals for food requirements. Later he put an end to nomadic life and the process of agriculture started which lead to a settled life. He cultivated crop plants and reared animals for his daily needs. Even now, the modern man depends on his surrounding for his staple food. Cereals, grams, oil seeds, tuber crops, spices etc. are the types of food derived by man from the ecosystem. Meat, egg, milk products etc. are also utilized from various animal sources.
2. **Fodder:** There are different types of plants and plant parts which are used as fodder to feed live stocks by human. It mainly includes grass fodders and non-grass fodders. Napier grass (*Pennisetum purpureum*), Setaria grass (*Setaria anceps*) etc. are some examples for the former and Subabul (*Leucaena leucocephala*), Agathi (*Sesbania grandiflora*) etc. are examples for latter.
3. **Fuel:** Human use different types of fuels from products of forest trees for cooking and other energy needs. These are the direct ecosystem services enjoyed by man since time immemorial. Even now many Tribes use forest products for their energy requirements.
4. **Fiber:** Cotton, Jute, Hemp, Silk, Flax etc. are some of the plants used by man for manufacturing fibers. They are used for different needs, from making clothes to construction of fishing nets and cordages.
5. **Water:** Main sources of water to man are Ponds, Pools, Rivers, Lakes, Ocean etc. This is the most important natural resource necessary for man which is depleting nowadays due to his non-judicious usage.
6. **Bio chemicals:** They include traditional medicines and pharmaceuticals, bio pesticides like extracts of Chrysanthemum, Neem, Premna, Hyptis etc. which are natural defenders of insect pests. They increase the crop productivity and the total produce.
7. **Alginates:** They are the products of polysaccharide, alginic acids derived from cell walls of Brown algae which are used as food additives, in textile printing and as ingredients in other products like medicines.
8. **Ornamental resources:** Hides, horns, shells etc. of animals and flowers and fruits of plants are used for aesthetic value. They bear the added values based on the decorative works on them. They were considered as the symbol of pride by royal Kings of olden times. Such collections are preserved in museums of both Government and private controlled.
9. **Generic resources:** These include the genes and genetic information used for animal and plant breeding and biotechnology. Areas with land races and wild relatives of crop plants in high concentrations are considered as centers of crop genetic diversity [6]. The germ plasma of wild relatives of crop plants and medicinal plants conserved in in-situ environments is the best example for this. Similarly various races or breeds of animals conserved for breeding programmers also come under this category.

2.2. Regulating services

Regulating services are the product of benefits obtained from regulation or maintenance of various ecosystem processes. Their asset value cannot be deciphered exactly though man is aware of their necessity and

this lack of knowledge generally leads to its non-judicious usage and further depletion in quality and quantity. The important ecosystem services under this category are as follows:

1. **Quality air:** The quality or stable air is maintained by ecosystem in different ways. Green plants release lot of oxygen to the atmosphere during photo synthesis. Photo synthesis is considered as the most important biological process happening on Earth because the whole survival of life depends on the oxygen released by this process. Similarly photo synthesis uses CO₂ of the atmosphere to synthesize organic food and in this way prevents the upsurge of this gas which could be detrimental to survival of life on Earth. As evident, it is difficult to give exact price or value for these services.
2. **Climate:** The change in micro climatic conditions and global climate scenario is due to changes in ecosystem. Untimely rain, floods, cloud burst etc. are the part of climate change which could be useful or distressing to population depending upon the locality, geography and economic conditions of the populace. The increased forest cover can induce precipitation and reduction of temperature at micro climate levels which suits the survival and adaptations in organisms. At a global level, the forests of the land along with algae of the oceans perform sequestration of carbon dioxide and reduce the process of global warming. At the same time, the death and decay of organic matter releases methane gas which is an apparent elevator of greenhouse effect.
3. **Water:** This is a major useful resource of ecosystem which gives innumerable benefits to living organisms. The land pattern and cover help in natural water storage process for which man is the major beneficiary. The water run-off, flood, aquifer recharge etc. are influenced by topography of the location and nature of the soil. The amount of water moving through a landscape can be modified by ecosystem which influences local climate, water absorption by plants, infiltration and flow patterns [7]. The soil characteristics are important determinants of quality and quantity of agricultural produce [8]. Vegetation cover of the soil reduces water-run off (denudation) and landslides. Another major service done by plants is the water purification. Many plants have got natural capacity to absorb, adsorb, accumulate or precipitate various salts and ions of heavy metals and directly help in purification of water. Eg. *Moringa oleifera*, *Strychnos potatorum* etc.
4. **Nitrogen fixation:** This process has been going on and the nitrogen is an important component of proteins which are the important organic molecule in plants and animals. The conversion of atmospheric nitrogen to nitrates and ammonia by physical, chemical and biological processes is called nitrogen fixation. Physical nitrogen fixation happens at the time of lightning in atmosphere. Chemical nitrogen fixation is done by artificial means through chemical fertilizers. The major one is the biological nitrogen fixation which is performed by bacteria like *Rhizobium leguminosarum* and blue green algae of the soil. They are doing enormous service to human by uploading huge quantities of nitrates and ammonia from atmospheric nitrogen which are absorbed by plants and reach to man through food chain.
5. **Disease outbreak:** A deviation in ecosystem pattern causes micro climatic changes which can increase or decrease various pathogenic organisms which are the agents of various water borne diseases like cholera, rat fever etc. The stagnant water also breeds various disease causing vectors like mosquitoes, house flies etc.
6. **Biological control:** Biological control is the control of populations of a specific species with the help of its natural enemies. Pest control strategies in Agriculture need a thorough understanding of predator ecology to ensure them enough food and habitat resources throughout their life cycles [9]. The rats are controlled by rat snakes in crop fields and this indirectly increases food production. The mosquito larvae are fed on by Gambusia fish which indirectly reduces the outbreak of Malaria, Filariasis, Dengue fever etc. Spotting the exact natural enemy of the pest is the most difficult task and once efficiently under taken, biological control can give high degree of benefits to farmers.
7. **Pollination:** This is the intricate interaction between plants and animals for the survival through sexual reproduction. The pollination is the process of transfer of male reproductive cell (pollen) of the flower to the female reproductive cell of the flower to effect fertilization and formation of fruits and seeds. Most of the world's food crops are pollinated by bees, birds, bats, trips, butterflies, moths, flies, wasps, beetles etc [10]. They provide yeoman service to man through pollination process which ultimately leads to seed development.

The seeds are the propagating structures in many plants and pollination is the biological process where a symbiotic type of interdependence is developed through mutual modifications. Thus, if insects are not conserved, there is the chance of non-development of seeds in many crop plants which could lead to utter

shortage of staple food in future. By this way, the symbiotic existence of both biotic and biotic factors provides regulatory service to man.

8. Storm: The mangroves are capable of controlling ocean waves like Tsunami and thus protect coastal population. The coral reefs also can reduce the speed of such waves. Thus they offer protective service from storms and hurricanes.

2.3. Cultural services

Cultural services include non-material benefits people gain from ecosystem. It may be through values related with spiritual enrichment, recreation, aesthetic feelings etc. It has the following facets in daily life.

1. Cultural value: The diversified ecosystems of one location can influence the culture of population of the location. The marine biodiversity will decide the culture of coastal community. The forest biodiversity decides the culture of tribal people and wet land biodiversity can be reflected in the culture of farmers and inhabitants of that area. The culture includes way of living, traditions, customs, food, exchange of ideas, festivals etc; which all depend on the type of available biodiversity and their sustainable usage.
2. Religious value: Biodiversity of a locality is firmly bound to religious values followed by that area. Use of specific species of flowers for 'pooja' and offerings to God is one of the examples in this case. The decoration of deity, place of worships and religious places are associated with the type of availability of biodiversity. Sacred groves are best examples for this because they are considered as the conserved natural flora of that locality. The concept of 'Dasa pushpa', star forests, reverence of snakes etc is deeply associated with the use of biodiversity for religious and spiritual values. The ecosystem also influences various types of knowledge systems followed by different communities [11].
3. Educational value: Ecosystem provides positive basis for various educational values. The live specimens of the ecosystem can be used to study the characteristics and general measures of entire populations. The populations of various species can be studied to understand the stability of communities and ecosystems and to assign rare, endangered and threatened status to plants and animals. Thus the whole idea of conservation of biodiversity and sustenance of entire organisms can be successfully programmed. It also forms the spots for art works, folk lore, national symbols etc. The concept of national or state bird and animal are instances where biodiversity can be used to represent the countries or states where they belong. WWF has Giant Panda as their mascot which represents the conservation of endemic and rare components of the biotic system.
4. Aesthetic value: People derive happiness in the beauty of various ecosystems like sea, deserts, hills, valleys, wet lands, river coasts, mountain peaks etc. These are the services which cannot be gauged monetarily. Estates, hotels, resorts, parks etc. prefer scenic locations to attract tourists and make money out of their aesthetic sense. Thus recreation and tourism are the two major parts of the aesthetic values provided by ecosystems.

2.4. Supporting services

Supporting services act as the buffer for all other ecosystem services. Their influence on people is indirect or not readily recognizable and may have a long time impact which may be cumulative. Climate change, soil formation etc. are examples for ecological processes coming under this category. Their immediate impact or usefulness cannot be noticed until hundreds of years. Water cycling, primary production etc. are other examples for supporting services.

3. Conclusion

Earth is a conglomeration of many ecosystem services. Anthropological alteration of one of the ecosystem of this group leads to irreparable changes in others. Habitat destruction for the cause of urbanization, invasion by alien species of plants (*Lantana camara*, *Mikania micrantha* etc.) and animals (African snail, African cat fish etc.) etc. can degrade the existing balance of a healthy ecosystem. Through the process of monoculture in the form of agriculture, man has toppled many of the naturally occurring ecosystem services like water regulation, nutrient cycling, pollination process etc. so, a sustainable approach is necessary to conserve the ecosystems so that human can enjoy ecosystem services in a judicious manner without any burden to future generations.

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The Publication fee is defrayed by Indian Society for Education and Environment (www.iseeadyar.org)

Cite this article as:

Dipak Uchampalli, Girish Kumar E, Vikrant S. Ecosystem services- An overview. *Indian Journal of Economics and Development*. Vol 5 (7), July 2017.