"ECOSYSTEM SERVICES" CONCEPT - ECONOMIC APPROACH

Ph.D. senior lecturer Giani GRADINARU
Academy of Economic Studies, Bucharest

Abstract

Most of the world population depends, in survival terms, on the way ecosystems function. Final products of nature represent services provided by ecosystems. Round the concept "ecosystem services" gravitate most of solutions embodied in the policies and strategies protecting biodiversity. The main types of services provided by ecosystems, as well as their trend is analyzed identifying the main factors generating changes taking place in ecosystems (population, economy, socio-political factors, scientific, technological, cultural and religious factors, climate change, fertilizers use, habitat change).

Key words: ecosystem services, economic approach, determinant factors

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Continuous degradation of natural systems is a reality proved by several facts: continuous reduction of forest area, disappearance of numerous species and increase in number of threatened species, whitening of coral reefs, proliferation of exotic species etc. If current rate of biodiversity loss is kept, it is estimated that 1.3 billion hectares (about three EU27) will completely loose its original biodiversity until 2050. Extinction rate is estimated to be about 1000 times higher than natural rate and we face with the sixth extinction wave from life history on the Earth.

Changes have an important social impact, because most of world population depends in survival terms on the way ecosystems function. 70% of poor population lives in rural area and directly depends on biological resources providing 90% of food, fuel, medicines, shelter and transport needs. Over 3 billion people depend on marine biodiversity, while 1.6 billions rely on forest products. Habitat degradation and loss of biodiversity threatens life for over 1 billion people living in arid and semi-arid zones, especially in Africa.

The analysis of biodiversity loss causes pointed out as final step, the economic mechanism. Under these conditions, economic approach became better and better outlined, both at theoretical and practical level, and contributed to the apparition of some new concepts by means of which complex interdependences between people and nature could be interpreted to

provide relevant information in decision-making. Among them, a key position is held by the **concept "ecosystem services"** round which most of solutions embodied in the policies and strategies protecting biodiversity gravitate.

Economic approach of nature is born from several theories developed since the 18th century. The notion of ecosystem services has a relatively recent origin, close to the beginnings of coherent concerns about environment protection.

Analyses of conceptual evolution are carried out in specialized literature. Most of viewpoints divide the process into three stages: origin and genesis; consolidation; construction of market instruments.

Origin and genesis. Concept "ecosystem services" was introduced in 1981 based on previous studies pointing out social value of nature functions in the sixties and seventies papers showing that several processes in the nature serve human society. In the seventies and eighties, more and more authors began to formulate ecological problems in economic terms to point out the dependence relation between society and nature and to enhance public interest into nature preservation. The reason was explanatory illustrating the way in which biodiversity disappearance affects ecosystems functioning and this change leads to human welfare diminish.

Consolidation. Introducing the concept "ecosystem services" the research agenda was stimulated by activity of some research institutes at the beginning of the nineties. Major contribution had global evaluation from [1]. Monetary results presented here had major impact on science, as well as on politics.

No.	ECOSYSTEM SERVICES	THOU BILLION USD/ YEAR
1.	Soil formation	17.1
2.	Recreation. tourism	3.0
3.	Substances recycling	2.3
4.	Water cycle and water resources usage	2.3
5.	Climate usage (temperature, precipitations	1.8
6.	Habitat, biodiversity preservation	1.4
7.	Protection against natural risks	1.1
8.	Production of food and raw materials	0.8
9.	Genetic resources	0.8
10.	Gas balance in atmosphere	0.7
11.	Pollination	0.4
12.	Others	1.6
Total		**33.3**

Source: [1]

Monetary resources paid not only attention but also critics regarding the methodologies used creating a favorable crucible for the research focus and potential. The clarification at theoretical level as well as the elegance of the concept reason, corroborated with the more and more clear signals regarding the emergency of actions as a result of progress in the implementation of UN

Framework Convention regarding Biological Diversity (CBD) propelled the concept of ecosystem services in the core of debates elaborating the policies in this field. Among significant events in this regard it is the adoption of Ecosystemic Approach at the Conference of CBD Sides from Nairobi in 2000.

The consolidation of ecosystem concept and universalization of their use to elaborate the policies was finalized by the project Millennium Ecosystem Assessment (MEA) under UN aegis. Here, 1360 experts from 95 countries took part in and it was the widest action focused on the situation and perspectives of global ecosystem. MEA focused on the notion of ecosystem service using a strongly anthropocentric approach. It was justified by the creation and development of some communication channels, with strong impact on the public. MEA also points out some connections, underlining that functioning of global ecosystem is totally essential for human welfare and shows the importance of biodiversity in this regard.

Ecosystem situation is only one of factors affecting human welfare. For instance, human health is the combined result of ecosystem situation, access to medical services, income level and many other factors. The interpretation of trends for welfare indicators should have in view several influence factors.

The impact of ecosystem change over human welfare is often subtle, hard to be noticed, but not less important; to be significant the impact should not be drastic. A relatively low increase in prices of food as a result of some low harvests of soil quality degradation will affect human welfare, even if nobody dies of hunger.

In order to correlate ecosystem situation with human welfare, two directions could be adopted. It could be directly correlated the trend of ecosystem situation with the change in human welfare or it could be noticed the impact at level of one group affected by bio-physical and socio-economic processes. The impact of water contamination over human diseases could be estimated correlating the concentration of contaminants from water resources with the incidence of gastro-intestinal diseases at population level, except the influence of other factors affecting this relation. Alternatively, the impact could be estimated using a dose-response function pointing out the incidence of diseases related to the concentration of polluting elements to estimate the increase in the diseases probability. The results could be combined with data regarding the population using the contaminated water resource and will get to the prediction of total number of diseases.

Both approaches assume the outrun of numerous difficulties. The efforts of direct correlation of ecosystem situation with human welfare are difficult because there are many other influence factors. The incidence of

breathing diseases does not depend only on the concentration of air polluting elements, but also on food elements, habits (smoking), exposure (duration, intensity) etc. It is recommended to analyze these relations at low scales, where such relations could be more clearly identified.

Ecosystem services are to dethrone the concept of biodiversity easily adopted at the beginning of the eighties, which proved to be inadequate as knowledge advanced in the field of preservation biology. After the publication of MEA reports, the specialized literature as well as international projects on ecosystem services exponentially increased.

The fact that other environment problems were also approached in economic terms, contributed to the extension of using the ecosystem services too. Among them, there are the Stern report on economy of climate change. Following this model, the European Union (EU) launched the initiative Postdam – Biological Diversity 2010. Out of this developed the project Economy of ecosystems and biodiversity (TEEB) which is to estimate the cost of inaction in terms of ecosystem services decline.

Construction of market instruments. At the same time with the development of monetary evaluation methodologies of ecosystem services, it was increased the interest for building up the market instruments creating the preservation incentives. Among them, there are Market Ecosystem Services (MES) and schemes of Ecosystem Service Payments (PES).

Although "trading" of ecosystem services is considered a relatively new, still emergent and experimental process, these services entered the market mechanism by means of price incentives developed within Common Agricultural Policy (explicitly oriented to the increase in environment quality and keeping the biodiversity), as well as by environment taxes on energy. PES and MES formal delimitation and their wide promotion as integrated preservation instruments was mostly developed in the last decade.

An interesting experience in this regard is the system "banks of humid zones" which developed in USA where the legislation on water administration stipulated the possibility of humid zone users to purchase permits in order to change them in exchange of commitment to create or reconstruct higher humid zones in other localities. The cost of these zones creation/administration reached almost 90 000 USD per hectare. Other similar markets are carbon markets which developed since 2000. Among the most important ones we mention the Scheme of Emissions Trading from United Kingdom, Climate Stock Exchange from Chicago (launched in 2003). The first international experience is the system launched in 2005 at EU level, setting up trading mechanisms for six green house gas.

PES were defined as voluntary transactions and were conditioned on

some well defined ecosystem services. They develop between supplier and user. Basic idea on which rely this mechanism is that users of provided services will assure the suppliers compensation. The best represented ecosystem services in these schemes are carbon sequestration, providing the habitat for threatened species, landscape protection and hydrological functions. The first PES was implemented in Costa Rica, today existing numerous applications in various partnerships [4]. At international level, REDD program is proposed which is a mechanism with double purpose: combat the climatic change in post-Kyoto scrip and preservation of biological diversity.

At present, although the problem of ecosystem services enjoys an enhanced attention from the researchers, the significance of the concept further being the subject of different interpretations.

Ecosystem services - definitions

- Ecosystem services represent flows of materials, energy and information from natural capital stocks which combine with the services of manufactured and human capital to produce human welfare [1]
- Processes by means of which environment produces resources which are free of charge considered by people, such as clean water, timber, habitat, pollination.
- Ecosystem services are benefits obtained by people from ecosystems [6]
- Ecosystem services are components of nature directly consumed or used to produce human welfare [2]
- Conditions and processes by which natural ecosystems and component species support and fulfill human life. For instance, clean water supply, maintenance of a constant climate (carbon sequestration), culture and flora pollination, fulfillment of cultural, spiritual and intellectual needs of people.

Definitions point out three significances at least. Ecosystem services could be flows/processes, benefits and components. First of all, decisions should have in mind maintenance of an adequate intensity, secondly, it is introduced the way in which human welfare is reached (utilitarian approach) while thirdly, objectives would be expressed in the stock dimension (of natural capital). In the perspective of quantitative analysis it is important to clarify these aspects and point out the last alternative, which can correlate with accuracy of benefits.

[2] approaches the problem of ecosystem services in the context of need to set up standard accounting units at macroeconomic level. In this regard, several definitions are enumerated as well as lists of services and

clarifications on essential aspects are done for the feasibility of quantitative analysis: interdependence between services, measured subject, relation between services and benefits.

Ecosystem services are final products of nature. If this distinction is not done, the value of intermediary goods will be registered twice, because it is also found in the value of final goods. Because products of processes from nature do not represent services, it does not mean they have no value, but this value should be pointed out in the value of the service.

Ecosystem services are components of nature (things or characteristics) and not flows or processes. They are intermediary on one side and much more difficult to be quantified on the other side.

It is underlined that services are not benefits because for the benefit production it is also necessary the contribution of anthropic capital components, resuming thus the idea of [1] regarding the combination of those two types of capital providing the ecosystem services. Recreation service is often considered a service of ecosystem, although for its manifestation it is necessary the existence of transport and accommodation infrastructure, which are components of anthropic capital. Taking into account these restrictions, services are identified and grouped in keeping with their benefits.

Discussing the ecosystem services, we also refer to the approach from [6]. Generally, authors agree to this, but consider the definitions for regularization and cultural services to be too general to be practical, because refer to processes and functions not to components.

Determinants are represented by natural or human factors which directly or indirectly determine changes within the ecosystem. Direct determinant influences unequivocally the ecosystem. Indirect determinant acts dimmer modifying one or more direct determinants. According to [6], determinants are grouped as follows:

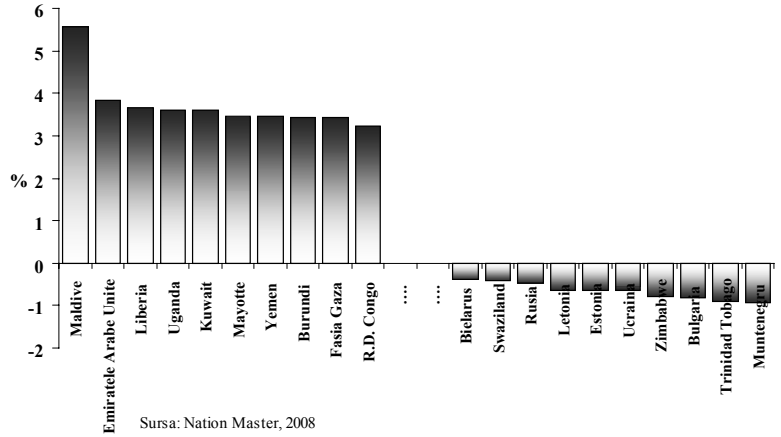
- indirect determinants: population (demographic), economy, socio-political factors, scientific and technological factors, cultural and religious factors;
- direct determinants; climate change, fertilizers use, lands conversion, leading to change in habitat and invasive species and pathogen agents.

Global **population** doubled in the last forty years and increased by two billions in the last twenty five years. At present, the world population is almost seven billion inhabitants.

Analyzing demographic growth at territorial level it is easily pointed out the determinant contribution of developing countries to global trend. Nevertheless, it is difficult to do global appreciations, because we face with

an unprecedentedly diversity regarding demographic situations of various regions and countries.

Countries with the highest and lowest growth rates



Sursa: Nation Master, 2008

Some developed countries further expect to significant growths of population (for instance, USA), while developing countries such as China, North Korea and South Korea register a lower growth trend.

Analyzing the structure by area, it results the global trend of urban population growth. Since 2007, urban population exceeded rural population [3]. On the other side, towns occupy under 3% of land area, indicating the extension of crowded zones. Regional rates of urbanization vary a lot. In the countries with high income, urban population reaches 70-80% of total. In some developing countries, such those from Africa, rural population prevails, while in Latin America urban population is 75%.

Increase in global population is expected to stop before the end of the XXI century to about 10 billion inhabitants. Growth rate of urban population reached the maximum in the sixties. Represent 1.18% at 2010.

World population and average growth rates in various years (1950-2010 period)

YEAR	WORLD POPULATION (MILLIONS)	PERIOD	GROWTH RATE (%)
1950	3516		
1955	2751	1950-1955	1.77
1960	3019	1955-1960	1.80
1965	3334	1960-1965	19.4
1970	3693	1965-1970	2.02
1975	4076	1970-1975	1.94
1980	4450	1975-1980	1.77
1985	4837	1980-1985	1.76
1990	5246	1985-1990	1.75
1995	5713	1990-1995	1.54
2000	6.115	1995-2000	1.35
2005	6512	2000-2005	1.26
2010	6850	2005-2010	1.18

In the last decades, demographic growth will be focus on the poorest urban zones in South Saharan Africa, South Africa and Middle East.

Demographic ageing process becomes more and more obvious. Industrialized countries will register the highest ageing degree, while in the developing countries, ageing rate will be accelerated.

Global **economic activity** increased by almost seven times during 1950-2000. Although this period also registered an accentuated demographic increase, the income level per capita almost doubled. This determinant is strongly different at territorial level.

As the income level per capita increases, the consumption structure is changing, having the potential to influence the ecosystem situation and implicitly their capacity to provide services. The income rise determines lower expenditure for food and higher consumption of industrial goods and services. At the same time, the composition of consumer diet is changing due to lower consumption of starch products (rice, wheat, potatoes) and of more fats, meat, fish, fruit and vegetables.

Energy and material intensity, respectively materials consumed to produce an economic result unit, becomes lower if GDP increases per capita. Energy and materials productivity increases as macroeconomic productivity improves. In a historical perspective, the increase in productivity is outrun by economic growth. The consumption of energy and materials grows in absolute terms.

Governmental interventions through measures of domestic policy (taxes and subsidies) could have important economic and ecological consequences

both in the country they were adopted and in other countries. The subsidies for conventional energy sources are estimated to 25-300 billion USD per year. During 2001-2003, agriculture was subsidized in OECD countries by over 300 billion USD per year. OECD protectionism and subsidies determined costs of 20 billion USD for developing countries by losses of income in agriculture [6].

Policies distorting international trade flows could have negative economic consequences. The nations with reduced commercial barriers, respectively open economies and transparent governmental processes are to have higher rates for income per capita. International trade is an important source for economic earning because allows the exploitation of comparative advantage and accelerates more efficient technologies and practices diffusion.

Socio-political determinants comprise forces which influence the decisional process, including public participation to take the decisions, mechanisms to solve the conflicts, the state role compared to private sector, education level and knowledge.

In the last fifty years, significant changes took place in socio-political determinants. Among them we enumerate the diminish of authority centralized governments and increase in democratic ones.

The woman part in society is changing in many countries, average level of compulsory education grows and actions of civil society is getting more intense (NGOs and other organizations involvement in decisional process).

Trend of democratic institutions enhanced local community power, of women and of households poor in resources. An increase in the nations involvement in multilateral environment agreements is registered. The importance of state compared to private sector – as supplier of goods and services, employer and innovation source – is declining.

In order to understand **culture and religion** as determinant of ecosystem change, it should be regarded by values, confidence and norms shared by groups of people. Culture conditions the individual perception over the world, influences what is important for people and suggests the course of actions.

The formulation of human behavior generally accepted had as starting point besides facts and material proofs, confidence, proposals, which constituted the conception over origin, organization, purpose and functioning of the universe, an external factor imposing several rules. Religion had and still has a strong influence over individual and collective behavior being the institutional representation of moral norms.

Anthropocentrism of approaches from various religious cultures varies as significance at level of man-environment ratio from total domination

to egalitarianism. Taking into account science progress, to identify direct relations, religious perspective can seem old fashioned as reason became part of our going on. Nevertheless, religious faith should not be neglected. It is built in human conscience and subconscious, so its influence remains strong at present too [4].

General comparisons of cultures did not prove to be useful because they did not succeed to surprise major differentiations of values, faiths and norms. Cultural differences have an impact over direct determinants. Cultural factors could influence consumption characteristics thus becoming a special importance determinant for the changes registered at level of ecosystem services.

Development and spread of **scientific knowledge and technologies** exploiting this knowledge has deep implications over ecological systems and over human welfare. In the XX century huge progress was registered to understand physical, chemical, biological and social processes and to implement this knowledge for the human use.

Increase of productivity implementing the results of the research, the new technologies is estimated to be determined for over 1/3 of GDP growth in USA, the ratio being more favorable (up to 2/3) if OECD countries are taken into account.

Impact of science and technology over ecosystem services is the most obvious in case of food production. Most of food production growth in the last forty years is determined by growth of yields and not by extension of cultivated area. Growth of yields for the main crops is significant: 208% for wheat, 109% for rice, 1575 for maize.

"Green revolution"

"Green revolution" consisted in the change of agricultural techniques as follows:

- give up monocultures and adoption of the most adequate crop rotations;
- improve biological material – species and assortments cultivated, favoring those with high productivity, physical resistance (for temperature, drought, poor soils in various nutritive elements) and biological resistance (for diseases and damage attack);
- intensive use of chemical fertilizers and pesticides (agriculture chemicalization);
- extend irrigated areas.

Respective measures lead to spectacular growths of food production at world level, as well as in certain regions with developing countries. Three agricultural systems have been developed:

- *Industrial agriculture*, practiced in USA, Europe, Australia, New Zealand, with high capital investments, cultivation performing technologies, storage, transport;
- *"Green revolution" type agriculture,* possible in rich regions, with high agricultural resources, situated in field regions, with irrigation possibilities, such as those from South and South East Africa, North Africa and some countries from South America;
- *Agriculture poor in resources,* practiced in agriculture improper zones due to lack of water or soils with low fertility, such as countries from Subsaharan Africa, Latin America and Asia.

Source:[4]

Unplanned effects of technological progress are stronger and stronger, several times because of degradation of ecosystem services.

Accelerated eutrophication because of chemical fertilizers use, apparition of extremely contaminated zones, waste accumulation, diminish of marine fish and mammal populations, change of hydrological regime, climate change are only few of environment problems associated to the application of modern technologies at large.

For land ecosystems in the last fifty years, the most important direct determinants of change in ecosystem services there are change in land use, especially land conversion for agriculture, and application of new technologies which significantly contributed to higher services regarding food, timber and fiber supply.

Deforestation and forest degradation affect 8.5% of world forests, half of these areas being situated in South America. They were more intense in the inter-tropical space, although few data regarding boreal forests create difficulties over global comparisons. About 10% of arid and deserted lands in

the world are considered degraded, most of these areas being situated in Asia. Cultivated areas represent 30% of land area.

For marine ecosystems and their services, the most important direct determinant in the last fifty years was fishing. Improve the marine fishing technologies made possible the extraction of considerable fish biomass from marine ecosystem. According to FAO estimations, mankind reached maximum level of biomass which can be extracted without producing significant changes in the ecosystem. For instance, in Thailand Gulf, there are not animals situated on upper trophic levels, this system being dominated by lower consumers. Researches in the West Africa and North Atlantic indicate similar changes. FAO estimates that about half of monitored fish stocks are exploited at maximum capacity and there is no possibility to enhance captures.

For fresh water ecosystems and their services, in keeping with the region, the most important direct determinants in the last fifty years are change of hydrological regime, invasive species and pollution, especially charge with nutritive substances. Introduction of invasive exotic species is one of the most important causes of species extinction from fresh water ecosystems. Waters of North America estuaries are strongly invaded by crustaceans and mollusks, their distribution being mostly overlaid on commercial routes.

In the last four decades, excessive overload with nutritive substances was pointed out as one of the strongest determinants of land ecosystem change, of fresh water, as well as marine ones. Synthetic production of nitrogen fertilizers represents the main determinant of food production growth. Application of chemical nitrogen fertilizers increased five times since 1960, but the yield of active substance use by cultivated plants is only 50%, thus half of mobile nitrogen reached in the hydrographical system.

Excessive loading with nutritive substances can determine algal blooming, diminish of drinking water resources and euthrophication of fresh waters, low oxygenation of coast ecosystems, emissions of nitrogen protoxide which is one of green house gas and urban pollution by emissions of nitrogen oxide.

It is estimated that the efficiency of nutritive substances use can be improved by technologies with higher congruence among cultures requests and their supply from various sources, without diminish of farmers income.

Many of ecosystem services diminish when inside and coast waters euthrophized. Water from euthrophized lakes has higher treatment costs. In these waters, it is diminished the frequency of fish species with high commercial value, as well as the possibility to use them by tourism.

Unpleasant smell of putrescent algae and presence of toxins released by green blue algae changes one of the biggest tourism attractions – water body - into a rejection factor.

Climatic change taking place in the last century has already a measurable impact over the ecosystems. It is pointed out by global average temperature which registered a growth of 0.6 degrees Celsius, by the change in the precipitations regime at territorial level and by their annual distribution, by the level of seas and oceans higher by 0.1-0.2 meters and the diminish of area covered with ice. In 2010, several thermal records were registered. March and May months had the highest average global temperatures from the monitor history.

Projections on the evolution of global average temperature show that it will increase by 1.4-5.8 degrees Celsius till 2100. Changes in the precipitations regime will enhance the regions aridity which are already characterized by water deficit and new regions will enter this category, especially from Mediterranean and temperate zone. Increases in the frequency and intensity of precipitations will be also registered in other regions. Synthetically, climatic change under hydrological relation can be described by the fact that arid regions will become more arid, while in humid regions the quantity of precipitations will enhance. These changes of climate will lead to more intense geo-morphological processes of surface (erosion, landslides, mud leak etc.) with extreme social implications.

Ecological effects of climatic change were already limited in certain regions by changes in the species distribution, populations, important moments from reproductive and migratory cycle, the frequency of diseases and damage incidence in the forest ecosystems.

Biological invasions represent another direct determinant affecting ecosystems. The movement of organisms due to human activity lead to a major alteration of the species distribution.

In certain ecosystems, the invasions of exotic species lead to native species extinction. In USA, invasion of exotic species of plants, animals and microbes is considered responsible of 42% diminish of native species on the red list. Ecosystem services modified after biological invasions especially affect agriculture, fishery and aquaculture, forestry and pasture capacity. On the other side, exotic species also bring benefits enhancing the potential of food production.

Conclusions

Economic approach of nature has origins in several theories developing since the XVIII century. Notion of ecosystem services has a relatively recent origin close to the start of coherent concerns for environment protection, respectively the seventies. Analysis of the concept "ecosystem services" evolution suggests the division of the process into three stages: origin and

genesis; consolidation; construction of market instruments. At present, although the problems of ecosystem services enjoys a high attention for the researchers, the concept significance is further subject of different interpretation. Direct and indirect factors such as population, economy, socio-political factors, scientific and technological factors, cultural and religious factors; climatic change, fertilizers use, land conversion lead to the habitat change and invasive species and pathogen factors, determine changes of ecosystem services.

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