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**From biodiversity to economy – there is only one *oikos***

**Abstract:** *Humans benefit from their natural surroundings in various ways and much of the economic activity is underpinned by biodiversity and ecosystem functions. And yet, there is an apparent paradox that they haven't been properly accounted for by economic calculations and policies, which results in their rapid degradation and loss. Data from around the world suggests that if such a trend continues, sustainable, equitable and efficient development and growth may not be possible to achieve.*

*This article aims to explain biodiversity and how it translates into economic benefits by providing ecosystem services that human population uses and depends on. Demonstration of this link advocates the integration of ecological and economic knowledge and invites economists and policy-makers for an increased involvement in biodiversity conservation. Finally, the issues of biodiversity, its use and impacts on economy are discussed in Montenegrin context.*

**Key words:** *biodiversity, ecosystem services, conservation, economic valuation, natural capital*

**Introduction**

Biodiversity is a relatively recently coined term that has permeated scientific and popular literature since the 1980's, and is becoming widely used in common language to describe the variety of life-forms on Earth. In its basic and most widely understood and used interpretation, it stands for the number of different species present on a particular spatial scale, such as when, for example, we count the number of species on Earth, in a particular country or in some geographic region, usually for the purposes of comparison. However, term biodiversity also describes the levels of variation and diversity below and above the species level – namely on the level of genes and ecosystems respectively.

Genetic diversity represents a variation in genetic make-up between species, as well as between individuals of the same species, as it can produce variation in any of the

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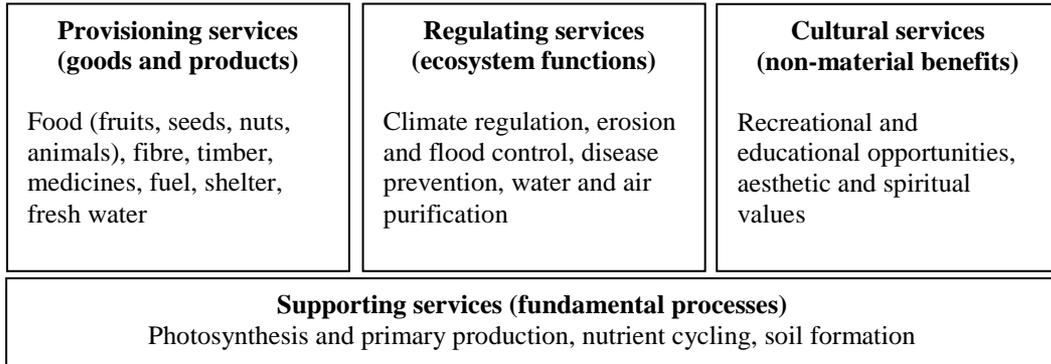
individual traits and features, such as size, growth rate, reproductive success, ability to tolerate temperature extremes, to resist diseases or catch prey. Genetic diversity is a product of evolutionary history and adaptations to particular environmental pressures (naturally or artificially induced), and it is usually spatially heterogeneous, so that populations of the same species can have very different genetic composition, which can ultimately lead to them splitting into new species. Such genetic diversity and differentiation within the same species is best exemplified by various breeds and races of domesticated plants and animals.

Finally, species engage in a whole suite of ecological interactions with each other and their environment, creating ecosystems, and the spatial diversity of such interactions presents the third level of biodiversity. A natural forest is an ecosystem with lots of interacting species, more complex than a desert, but a landscape all covered with one type of forest has less ecosystem diversity than the same-sized landscape that is a mosaic of such forest, grasslands and freshwater ecosystems.

In nature, however, those three levels of biodiversity create one continuum, and cannot be easily separated. Genes make up individuals and determine their behaviours and life-history traits. Those will be translated into population dynamics through reproductive rates, mortality, dispersal and migration, and the genetic divergence between populations can lead to creation of new species. Species dynamics is further translated into community and ecosystem dynamics through ecological interactions between populations and species (such as predation, competition, mutualism, parasitism), so when we try to assess biodiversity at a particular scale, all those components should be taken into consideration.

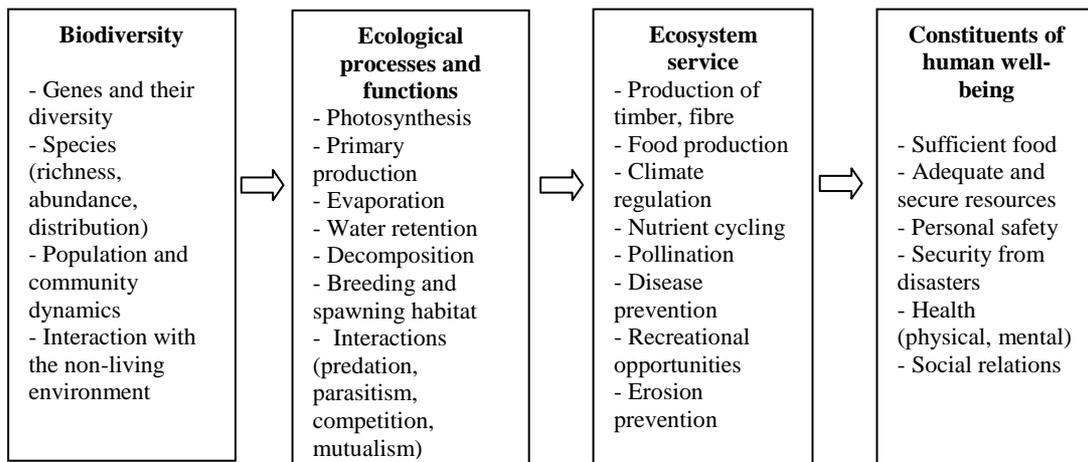
### **The importance of biodiversity - ecosystem services**

As biological species, humans have always been a part of their natural environment and have used and depended on biodiversity in various ways. We have used and continue to use biodiversity directly, as nature-provided goods, such as food (fruits and seeds, fish and game animals), timber, fuelwood, fibre and medicines (an extensive review given by Chivian & Bernestein 2008). But moreover, we derive many indirect benefits from species and their interactions, most of which we are not even aware of, or take for granted, such as the oxygen in the air that we breathe, clean water, climate regulation, protection against floods and droughts etc (review in EASAC 2009). All those direct and indirect benefits that we derive from biodiversity are now collectively termed ecosystem services. Since those services are multifold and complex, the Millennium Ecosystem Assessment review (2005) has provided a now widely-used classification of ecosystem services for the ease of observation and research approach, and they are given in Figure 1.



**Figure 1** – Classification of ecosystem services based on the Millennium Ecosystem Assessment (2005)

As we can see, apart from being direct or indirect, ecosystem services can also vary in spatial (local, regional, global) and temporal (short-term, long-term) scales of relevance. As an illustration, we can observe a natural forest – it is a complex system of interacting organisms – trees, microbes in the soil, herbaceous plants, invertebrates that decompose decaying matter, higher animals that act as predators etc. It can provide local human populations with food (forest fruits, mushrooms, seeds), fibre, medicinal plants, as well as shelter and recreational opportunities. It may also support industrial activities such as timber production. Further, its system of tree roots binding soils prevents erosion, and together with animal burrows helps retain and filter freshwater and replenish aquifers, the benefits of which can be felt in communities downstream from this forest as well as in sectors such as hydropower, water supply or irrigated agriculture. This same forest also regulates microclimate through heat absorption and transpiration that affects precipitation, produces oxygen as well as stores CO<sub>2</sub> contributing to carbon as well as nutrient cycles. A more general illustration of those links is provided in Figure 2.



**Figure 2** – An illustration of how biodiversity translates into human benefit through providing ecosystem services.

There are still theoretical arguments and practical problems in deciphering how biodiversity translates into ecosystem services and thus anthropocentric benefits (Schwartz *et al.* 1999). With provisioning services, the link is more obvious – the number and size of fish populations can be relatively accurately assessed and translated into food and economic income from fisheries. But with supporting or regulating services, the links between biodiversity elements and services the system provides are less obvious, and are more dependent on functional roles and interactions that can be hard to decipher (for example – the role of trophic webs, i.e. predator-prey interactions, in controlling the populations of species that are agricultural pests). However, studies are clear that complex natural ecosystems with diversity of species, populations and their interactions will be more resilient and better able to generate services than degraded or uniform systems consisting of only a few species, such as for example plantation forests or heavily modified agricultural landscapes (EASAC 2009). This additionally stresses the importance of preserving local populations and community and ecosystem interactions for maintaining the services we benefit from.

### **The loss of nature capital – causes and consequences**

Species and population extinctions are natural processes that can happen because of intrinsic and extrinsic factors, and paleontological and historic records provide plenty of evidence of species that once existed but do not anymore (Ridley 1996). However, the scale of the species loss that is happening in the recent past as a consequence of human activities highly exceeds natural background extinction rates, even by a thousandfold according to some estimates (Frankham *et al.* 2002). Apart from species disappearance from the face of the Earth, even more worrying are the local extinctions of populations and disappearance of genes conferring local adaptations, and the consequent loss of ecological interactions which can cause further species/population losses on ecosystem scales, and overall decrease in ecosystem resilience to new perturbations (Begon *et al.* 1996).

The negative costs of biodiversity loss are becoming increasingly apparent, as consequences are starting to emerge in the form of the loss of valuable goods and services we derive from it and on which our welfare and development depend. Although, as noted above, there is still a lack of clear understanding how biodiversity translates into some of the ecosystem services, there is no doubt that dependence exists, and with the rapid loss of biodiversity, we face a decline and degradation of valuable services it provides. Indeed, Millennium Ecosystem Assessment (2005) has estimated that 60% of ecosystem services have been degraded due to the loss of biodiversity. Another study focusing on the European Union (Kettunen & ten Brink 2006) has collated concrete examples demonstrating the loss of ecosystem services as a direct consequence of biodiversity loss, outlining

the associated economic costs and social losses. Among the more interesting examples in that study is the one from Sweden, where the high level of eutrophication of coastal waters and consequent disruption of the ecosystem has led to a decrease of fish spawning rates reflected in the decrease of catch and losses of €6-8 mill/year for local fisheries, as well as the loss of recreational opportunities along the coast.

The main causes of those losses include habitat destruction (because of land use-changes such as conversion of forests and wetlands into agricultural or urban lands), overexploitation (for instance in commercial fisheries and hunting), pollution (discharge of organic and inorganic substances from agriculture or industry into the environment), invasive species (deliberately or accidentally introduced to new habitats by humans, where they disrupt local ecological interactions) and climate change that has become one of the main global environmental issues (Begon *et al.* 1996). Those drivers are a direct consequence of the rapid increase in the human population size, its demands and consumption rates, and associated social, economic and technological changes (Millennium Ecosystem Assessment 2005).

There is hardly anyone on Earth who is not, at least to a degree, aware of the links between humans and biodiversity and our dependence on ecosystem services. And yet, the conservation efforts and all the awareness raising campaigns carried out so far have provided rather limited results, so that we still witness loss of biodiversity and associated services, as the Swedish example above clearly illustrates. Although the drivers of this loss have been noted above, and efforts undertaken to reduce or mitigate them, the problem persists because its roots go deeper than that and are embedded in the traditional way that natural capital is viewed and valued. Connections in nature are complex, dynamic, non-linear, and it can be hard to predict consequences of certain human actions. For instance, a loss of some biodiversity element can result in a failure of ecosystem service far from the location where it has been lost (e.g. removal of a forest will affect water regime far downstream from that location), or much later in time (observed, for instance, after introduction of non-native species that in time become invasive and eliminate other species). Moreover, ecosystems can withstand perturbations and then crash rapidly (e.g. fish populations can withstand steady increase in fisheries until one point and then crash abruptly). Because of all that, it is hard to measure, monitor and report on natural capital in a way that can give reasonable predictions, so values of biodiversity and costs associated with its degradation and loss are rarely properly accounted through economic indicators and markets, nor reflected in policy-making processes or decisions of businesses and citizens (TEEB 2009).

Another level of complication in this story comes from the 'public good' nature of those services, meaning that both the benefits of biodiversity conservation and the

costs of biodiversity loss tend to go beyond the individual or group who initiates the action and be disproportionately distributed through the society, which makes them hard to regulate. This means it is almost inevitable that biodiversity will be underprovided by the market, as there are weak incentives for individuals to engage in conservation activities (either due to the fact that those who degrade biodiversity do not themselves face costs and losses from their actions, or because others will also benefit and so beneficiaries hope that others will pay the costs for “free-riding” behaviour). Biodiversity benefits and costs tend to be felt as externalities - as positive or negative consequences of an economic activity that is experienced by unrelated third parties, that are not reflected in the price of the goods or services being produced and for which no compensation is paid or received (TEEB 2009).

Therefore, despite the common consensus and increased awareness about the importance of biodiversity, its loss and consequent degradation of ecosystem services still persists, even on large scales. Because of all this, new approaches and attitudes towards biodiversity and its use and management are urgently needed.

### **Towards integration**

While conservationists traditionally argue for biodiversity protection based on ethical considerations and because of its intrinsic values that are independent of human needs, the last few decades have seen the development of new approaches based on economic paradigms. These are providing ways to value biodiversity through ecosystem services, which are based on anthropocentric values and directly or indirectly linked to human development and wellbeing, by assigning monetary values and designing new markets and incentives for those goods and services (Heal 2000, Kettunen *et al.* 2009). A study by Costanza *et al.* (1997), estimated that the average value of 17 selected ecosystem services is \$33 trillion, which is much higher than the global gross national product that at the time was \$18 trillion. Even if treated with much caution, this estimate was useful for drawing attention to the importance of ecosystem services to economy as well as for demonstrating their irreplaceability.

Although there have been ethical arguments on assigning monetary values to nature, as well as theoretical and practical concerns about those valuation techniques, given the scale of human activities and consequences to ecosystem services they incur, there is a dire need to revise traditional management and decision-making practices in order to incorporate the value of those services (TEEB 2009). While economic forces and factors undoubtedly provide the main causes of biodiversity and ecosystem loss, economics also offers a suite of tools to assist in their conservation and sustainable use.

Ecology and economy have for far too long been perceived as opposing disciplines, two completely discreet or mutually exclusive human endeavours that have little in common. And yet, the Greek word *oikos*, or home, is in the root of both ecology (“the study of the household”) and economy (“the management of the household”), and it indicates that in essence they are interested in the same thing – the relations between species, including humans, and their surrounding (i.e. the natural capital) and related interactions on which they depend. Despite that, those two disciplines have been treating the same subject matter in completely different and even opposing ways, with no initiatives to integrate theory and practical methods into one approach. Recent initiatives do take that path, because it has been recognised that human activities cannot be separated from the environment and that economy ultimately depends on the stock of materials and flow of services provided by nature. Therefore, economy needs ecological knowledge of underlying principles that govern functioning of ecosystems from which benefits are derived, so it can revise its theory and practical methods to incorporate information about nature capital. At the same time, it is unreasonable to continue conducting ecological work, especially in the context of conservation, if the needs of our society are not addressed.

Therefore, the role of economy in biodiversity conservation is becoming increasingly important, even unavoidable. In this new approach, the first step is the economic valuation of biodiversity and services it provides. The role of economists is then to work on designing and creating markets for ecosystem services that traditionally did not exist, like the carbon storage, watershed protection etc, so that the externalities referred to above can be “internalised” in people’s economic behaviour, and their values can be actualised and then traded. The result of such an approach, as it has been demonstrated by a growing body of examples throughout the world, is that this creates new incentives for biodiversity protection, even in the stakeholder groups that have traditionally been opposed to conservation, such are landowners, private business and industry (Daily *et al.* 2000, UNDP-UNEP PEI 2008, WCBSD 2011). The goal is to make it more economically worthwhile or attractive for people to conserve biodiversity in the course of their economic activity than to degrade it. In such a way, short-term private and long-term public interests can be accommodated at the same time.

### **Montenegrin context**

The ecological research studies of Montenegrin biodiversity demonstrate that our country has very high diversity indices, especially for some organism groups as well as diverse ecosystems, which make Montenegro an important biodiversity hotspot at regional, European, and even global scales (Ministry of Spatial Planning and Environment 2010). The causes of such diversity include our geographic position in the Mediterranean, which itself is one of global biodiversity hotspots (Conservation

International, web source), as well as in the South of Europe, where species took refuge during ice ages (Hewitt, 1999), diversity of climatic and geologic/paedologic factors (Radojičić, 1996) and long history of human-nature interactions.

We have used this biodiversity and continue to rely on it, so the services it provides significantly contribute to our society's functioning and economic development. A considerable proportion of Montenegrin population (38%) lives in rural areas (Ministry of Agriculture, Forestry and Water Resources, 2006) where they still directly depend on biodiversity and ecosystem services for their livelihoods (timber extraction for fuel, use of upland pastures for cattle grazing, collection of forest fruits and mushrooms etc). Moreover, Montenegro has adopted three main developmental directions that most closely rely on the supply of ecosystem services, namely; agriculture, tourism and energy sector, and this link will be briefly explored in subsequent paragraphs.

### *Agriculture*

Agriculture, forestry and hunting comprise 11% of the national GDP (Ministry of Health, 2009). More than 60% of Montenegrin agriculture production comes from cattle breeding, primarily sheep. Sheep are raised in a traditional manner, by free-ranging flocks that graze on upland pasture ecosystems, which comprise 62% of total agricultural area (Ministry of Agriculture, Forestry and Water Resources, 2006), and thus provide an invaluable service to our agricultural sector. Further, 39% of Montenegrin agricultural export consists of alcoholic products, predominantly wine and brandy derived from growing autochthonous grape sorts like vranac. Other sorts of agricultural plants and animal breeds specific to Montenegro, like onions from Crmnica, buša cows, pramenka sheep etc, may not have high production rates, but they are well adapted to local environmental conditions and thus extremely suitable for organic production as they don't require additional nutrient inputs or special care efforts (Marković *et al.* 2007). Finally, an important segment of the food production sector are fisheries, which depend directly on the natural fish stocks in marine and freshwater ecosystems, contributing substantially to local economies (especially in the Skadar Lake region) as well as complementing the tourism sector.

### *Tourism*

Tourism has been an important economic sector in Montenegro even during the times of Yugoslavia, but in the recent years it has become the main developmental orientation. Montenegro owes its status as a good quality tourism destination to still highly preserved nature. In this respect, the presence of natural and semi-natural landscapes still inhabited by wildlife is a service that provides a basis for development of various nature-oriented forms of tourism. Protected areas, in particular, whose mandate is to preserve designated natural habitats, play an important role in this respect. Another associated ecosystem service that our tourism

heavily relies on is the provision of drinking water – the most illustrative examples include springs in Skadar Lake and Crno Lake, both located within protected areas (National Parks Skadar Lake and Durmitor, respectively) where related ecosystems ensure the steady supply of good quality drinking water for tourists in main destinations along the coast and in the town of Žabljak.

### *Energy*

The third main economy of Montenegro is the energy sector, where the large section of current energy production and majority of envisaged developmental plans are based on the hydro-potential, which has been estimated to be among the highest in the world (Ministry for Economic Development 2007). And yet, the quantity of water, the reliance on its constant supply and prevention of sedimentation due to erosion, depends heavily on the watershed protection provided by the forest and other upland ecosystems, which is particularly important in the limestone landscape which makes up most of our country. Finally, much of heat energy consumption, especially in rural areas of Montenegro, still comes directly from forests, and will probably continue to do so considering social, economic and demographic trends and projections.

Unfortunately, the level of environmental degradation in Montenegro has been on an increase in the recent years. Outdated industrial facilities, increase of urbanisation and pressure on forests and aquatic systems (both freshwater and marine), illegal hunting and fishing, disturbance of natural habitats and other harmful activities have all been observed and are taking a toll on our biodiversity (Ministry for Spatial Planning and Environmental Protection 2007, 2010). Reasons are many - low public awareness, conflicts between users, plans and legal rules, lack of sufficient human capacities for nature protection (Vojinović 2011). But, as argued above, the root cause of continued nature degradation in Montenegro lies in the fact that environmental issues are not integrated in developmental policies and a decision-making process and that coordination between developmental plans and activities of different sectors is lacking. Unfortunately, this short-sightedness may mean that the very policies and plans that are designed to stimulate and maintain economic growth and development may in fact be undermining it.

In Montenegro, biodiversity conservation is mainly achieved through protected areas, and there have been recent requirements to increase the surface of land under protection in the face of EU integrations (Ministry for Spatial Planning and Environmental Protection 2007). Unfortunately, because questions of biodiversity conservation are not integrated into policies and economic decisions, protected areas continue to be managed poorly and perceived as a non-viable form of land-use that hinders development.

A study carried out last year has for the first time tried to estimate the benefits of ecosystem services for the economy of Montenegro (UNDP, 2011). Through applying standard economic valuation techniques, the study shows that protected areas contribute to our economy with €62mil/year. Although this study is restricted in scope (it is focused on five protected areas) and based on limited data and extrapolations from other countries (which it clearly states), the undisputed conclusion is that a significant contribution does exist and that protected areas, indeed, provide a flow of economically valuable goods and services and are a stock of productive capital that is not captured through standard economic methods. However, the study also demonstrated that despite providing economic benefits, there is significant public under-investment in protected areas (and thus biodiversity protection in general), which are not being managed to their full economic potential. So, if we continue to manage biodiversity in the same unsustainable manner, we will face substantial economic losses on the long-term basis. This is especially true if we consider other ecosystems not included in this study because they are not protected (like coastal ecosystems and forests for example), but the continued degradation and poor management of which can incur significant economic and social losses.

### **Final message**

It has been increasingly obvious that biodiversity provides many direct and indirect benefits and that its loss through unsustainable use can incur long-term costs on most sectors of economy and hamper further development. In other words, biodiversity protection is not a luxury that cannot be afforded, but a necessity that we cannot afford not to invest in, and that profitability and environmental protection and thus sustainability are not mutually exclusive, but can go hand in hand.

With its main economic sectors based on natural goods and services, Montenegro cannot afford to allow continued loss of biodiversity and degradation of ecosystems. With its orientation towards an ecological state and ambitions towards EU accession and competitive economy, Montenegro has to start to genuinely address the issues of biodiversity and ecosystem services protection, and allow them to permeate all of our political, economic and social policies and decisions. Economists should play an important role in that respect, by striving to understand ecological knowledge in order to work on valuation and innovation of new markets for those goods and services we obtain from nature. This can create incentives for biodiversity protection, especially to private businesses, that could not have been achieved by ecologists/environmentalists alone, and can also bring Montenegrin economy new products and a new edge that can boost its competitiveness on the regional and global markets.

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