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Full Length Research Paper

Economic of biodiversity: The importance of studies aimed at assessing the economic value of biological diversity

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Biological diversity has constituted the focal point of environmental economics and public politics increasingly over recent years. Ecological and economic approaches guide the determination of accurate policies for a sustainable future and in drawing an efficient roadmap. Based on an extensive literature review, this study reveals both the importance and limitations of studies aimed at the economic value of biological diversity within the descriptive analysis and the method of group evaluation. In this study, it is shown directly that, studies which are based solely on biodiversity are seen to be insufficient. It is said that, the use values and non-use values of biodiversity to be determined as monetary and it is understood that, further policies can be developed on this subject. This study targeted an interpretation of the economic valuation concept by approaching key studies aimed at building bridges between a nation's ecology and its economy. Revealing the value of the biological diversity both quantitatively and qualitatively, these studies reflect the difficulty in not only assessing the accurate evaluation regarding species and genetic differences, but also the ecological and economic substitution of possible biological diversity losses.

Key words: Biological diversity, economic valuation, species diversity, ecosystem diversity, bio-prospecting value

INTRODUCTION

Biodiversity had been included into the economic policies and the sustainable development model as a rising value in terms of economy and ecology during the 21st century. Biodiversity plays an important role in the global economy and sustainable development due to two main reasons.

"The first is that, it provides a wide range of direct or indirect benefits to mankind, which occur on both local and global scales. The second relates to how human activities have contributed to unprecedented rates of biodiversity loss, which threaten the stability and continuity of ecosystems as well as their provision of goods and services to mankind (Nunes and van den Bergh, 2001; Nunes and Nijkamp, 2011). Complex biodiversity indicates a healthy environment and a process of life-support required for the welfare of people through the various goods and services.

Biodiversity, which is also an important part of economical development, is classified as scarce resources in the scope of economic goods, with a significant strategic power for both local and global economies (Pearce and Moran, 1994; Tisdell and Wilson, 2006). The common and sustainable utilization of this power may be possible with the transformation to an economical value providing all the components of biodiversity (species, genetic, and ecosystem diversity). Therefore, attentions have shifted to the marketable

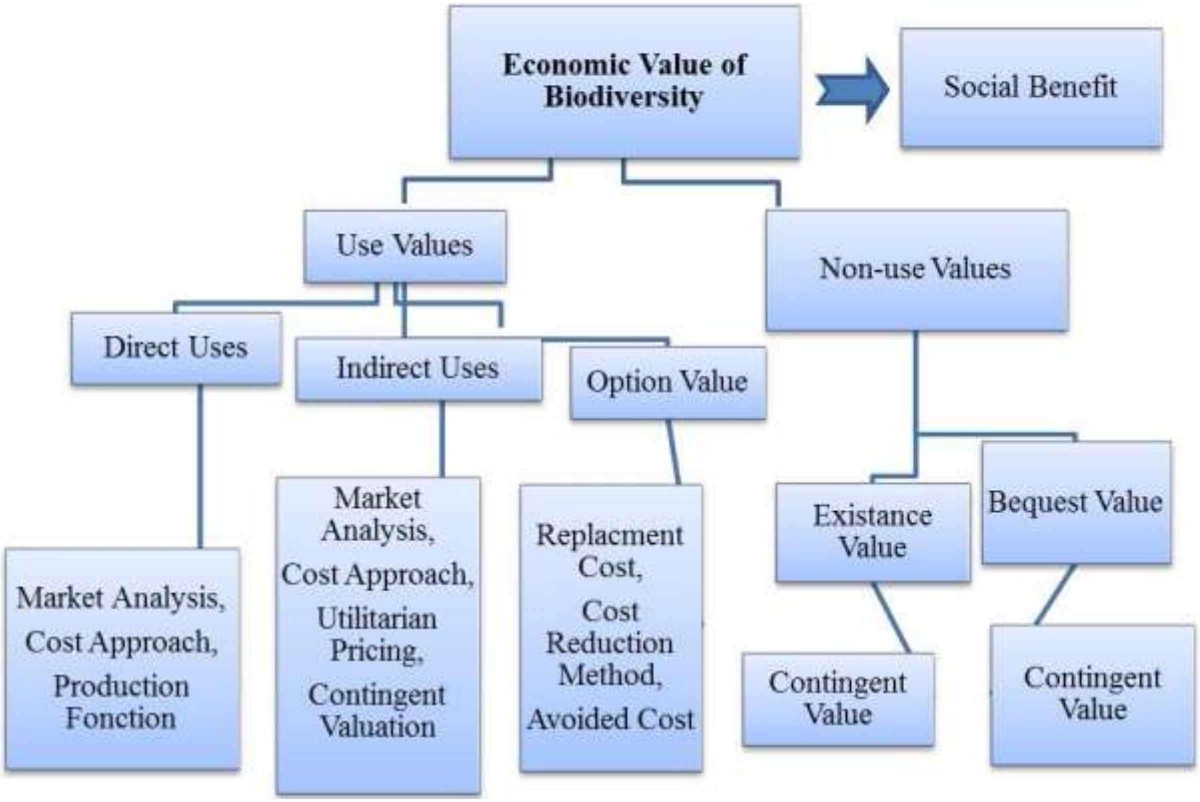

Figure 1. Methodological approach for valuation of biodiversity (Adopted from De Grood et al., 2002).

goods and services directly provided from both local and global biodiversity together with the analysis and evaluation that highlights the negative economic value of biodiversity loss.

The economic valuation studies which are based on an entirely human-centered approach take into account direct and indirect values of the production, consumption and unused values of biodiversity and they provide an opportunity to determine the monetary value on the basis of income to the mentioned values restricted (Costanza et al., 1997; Nunes et al., 2003; Saunders et al., 2006; De Groot et al., 2012). This economic valuation allows for a monetary evaluation of the value of biodiversity on the basis of revenue (Freeman, 2003; L'Opez, 2008). The determination of use and non-use values of biodiversity employs economical value techniques such as the market analysis, the production function, the hedonic pricing, travel cost and the conditional valuation (Figure 1) (De Groot et al., 2002; Hoffman, 2011).

Research carried out on the determination of an economic value contribute to identifying the role of biodiversity on ecological and economic systems, providing a way to follow the negative impacts on species, ecosystems and related goods and service losses. Within an ecosystem the extinction of a species has a direct affect on many other species and breaks down the previously existing balance (Xepapadeas, 2010). As a result of this, it has been observed that, certain key functions within the ecosystem are not fulfilled both inside and outside the system, together with the arrival of new species. It is highly unlikely the incoming species will continue to fulfil the exact functions performed by the now extinct species, leading to a breakdown within the ecosystem and possible habitat loss (Tisdell et al., 2006, 2007; Nunes et al., 2006). In this way, gradually decreasing biodiversity that has material, moral and functional values will disrupt the balance of nature and at the same time causing economical losses and the further extinction of some sectors. Furthermore, these economic valuation studies have a significant role in the conservation of biodiversity, through increased monitoring and the subsequent creation of necessary policies.

Historically, the bulk of research into biodiversity has been limited to species determination, identification and characterization, classification studies. Only recently this research turned towards highlighting the potential economic value of biodiversity. In recent years, research focus has been directed towards the transformation to the economic value of biodiversity by biologists, environmentalists and economists. This research stresses that, to transform the natural world and its biodiversity with all its components to a purely economic value, it must be supported by a multidisciplinary approach, while taken into consideration conservation and sustainable use. Under these conditions, it is seen that, economic valuation studies have become increasingly important for developing countries which have a rich biodiversity. Such approaches underline the relevance of policies all set to be transformed to the economical value of biological scarce resources. Therefore, stricter implementation of both local and international economic policies must be maintained to ensure the sustainable use of biologically scarce resources and the conservation of a regions biodiversity for future generations.

In this context, this research has analysed and displayed some key economic valuation studies emphasizing the importance of biodiversity with qualitative and quantitative sizes. It is clear that, the paucity of economic valuation studies plays a limited role in the determination of the direct and indirect using value of biodiversity, in the determination of the goods and services real value is offered by ecosystems and in the market analyses. It is important that, the expression of total economic value of biodiversity remains stable through the use of various economic valuation techniques and can thus, be employed in the development of applicable economic policies. This research is necessary in highlighting where there is a lack of relevant data and what manner of economic valuation studies have been done so far. It therefore targets which areas and in which sectors the valuation of biodiversity is significant.

Additionally, this research paper focuses on the analysis of biodiversity rather than merely natural resources, whilst looking into the use of experimental studies and the implementable evaluation methods and analysis the role played by recent biodiversity policy and the management of biodiversity indicators and the value information. In this sense, this research will help to resolve this relative dearth of valuations within biodiversity studies. It is noted that, certain measures be taken to allow for the understanding of the economic importance of biodiversity and overcoming of this limited situation.

METHOD

This research is based on an extensive literature evaluation. Some published data were collected through the internet from between 1992 to 2012. The compiled literature was evaluated systematically and analytically and classified according to several factors, namely goods and service functions of biodiversity, value categories, economic valuation methods, the author and year of study, species, etc. In the evaluation studies a systematic elimination between the similar and consecutive studies was performed.

The data set obtained was interpreted using “group evaluation and descriptive analysis methods”. These value categories are used in the measurement of economic value of the provided benefit from biodiversity.

(i) The studies that were evaluated according to ecosystem functions to the biodiversity; the studies were evaluated regarding ecosystem functions and services
(ii) The studies relating to genetic diversity and bio-prospecting
(iii) The sample research describing biodiversity and the species protection; research evaluated a single species in the fauna and flora diversity
(iv) The sample studies that evaluated the protection of natural habitat and many species

The identified value categories are shown in tables. These value categories are interpreted and discussed analytically and systematically in accordance with the results and conclusions subsequently reached.

FINDINGS AND DISCUSSION

Data related to the findings obtained from the group assessment and descriptive analyses, based on the literature review, are shown in tables under main titles. Further results were obtained through discussion.

Measurement of economic value of the provided benefit from biodiversity

Studies and methodologies that were evaluated according to ecosystem functions

Within existing economic valuation studies, it is unclear whether the focus is towards ecosystems and natural sources, and if they refer to biodiversity subjects or not. This is primarily due to the fact that, biodiversity is often associated with complex ecosystem functions and processes and how these can be linked to human welfare. Giving an economic valuation to biodiversity has proven to be a very difficult issue. Modelling and economic analysis of biodiversity comprehends the information and indicators of relations between the dynamics of ecosystems and the human economic activities. Therefore, there is a socio-economic relationship with the geographical differentiation of the economic valuation studies in biodiversity which further complicates implementation. As a result, “the source evaluation” and “the biodiversity evaluation” have been misused and this situation has led to paucity in research on the economic value of biodiversity.

According to the data gleaned from the literature, biodiversity creates various value categories within the ecosystem, including the regulation and production of habitats and formation function (Table 1). While the regulation and habitat value categories constitute indirect using values, the production and information function are direct use values. Likewise, while such ecosystem functions as a gas regulation, climate regulation, water reserve, soil control, and biological control constitute indirect use values. Value functions such as nutritional value, value for use as raw material, genetic and medical resource value and aesthetic value constitute the indirect using values. Both direct and indirect using values of ecosystem functions are evaluated through various approaches, including abstention cost, production

Table 1. Relationship between value functions of biodiversity, value and valuation techniques (Costanzabet al., 1997; White et al., 2004; Nunes and Schokkaert, 2003; De Groot et al., 2002, 2010a,b, 2012).

S/N	Ecosystem function	Economic value $/ha/year	Analysis method that was used	Values	Possible methods
	Regulation function				
1	Gas regulation	7-265	AC	Indirect use	RC/CV/GV/FI
2	Climate regulation	88-223	AC	Indirect use	RC/CV/GV/FI
3	Disruption value	2-7240	AC/RC	Indirect use	FI/HP/GV
4	Water regulation	2-5445	PD /AC/ FI	Indirect use	RC/HP/GV
5	Water reserve	3-7600	PD/RC	Indirect use	AC/FI/TC/HP/CV
6	Soil conservation	29-243	AC/RC	Indirect use	FI/HP/CV/GV
7	Soil composition	1-10	AC	Indirect use	RC/FI/CV/GV
8	Nutritional cycle	87-21100	RC	Indirect use	AC/FI/CV/GV
9	Waste control	58-6696	RC/CV	Indirect use	AC/FI/HP/GV
10	Pollination	14-25	RC/FI	Indirect use	DM/CV/GV
11	Biological control	142-195	RC/FI	Indirect use	AC/CV/GV
	Habitat function				
12	Shelter function	3-1523	PD/CV	Indirect use, existence value	RC/FI/HP/GV
13	Breeding function	142-195	PD	Indirect use	AC/RC/FI/HP/CV
	Production function				
14	Nutritional value	6-2761	PD/ FI/CV	Direct consump./option value	RC/GV
15	Raw material value	6-1014	PD/ FI/CV	Direct consump/option value	RC/GV
16	Genetic resource value	6-112	PD/ FI	Direct consump/option value	RC/CV/GV
17	Medical value	203-3248	PD/ FI	Direct consump/option value	AC/RC/CV/GV
18	Decorative value	3-145	PD/ FI	Direct consumptive use	RC/TC/CV/GV
	Information function				
19	Aesthetic information function	7-1760	HP	Direct non-consump use, existence value	RC/TC/CV/GV
20	Recreation and tourism value	3-6000	PD/FI/TC/HP	Direct non-consump use, existence value	RC
21	Cultural and artistic value	+++	CV	Direct non-consump use	DMP/FI/TC/HP/GV
22	Moral and historical value	1-25	CV	Direct non-consump use, existence value	TC/HP/GV
23	Value of use in science/education	+++	CV	Direct non-consump use	FI/TC/CV/GV

DMP, Direct market pricing; FI/PF, factor income/production function; AC, avoided cost; RC, replacement cost; HP, hedonic pricing, TC, travel cost; CV, contingent valuation; GV, group valuation.

function, substitution function, travel cost, conditional valuation, and group assessment. As seen in Table 1, the quality of the ecosystem, the goods and service function and whether ecosystem services have direct market value are important factors in determining the method to be used in valuation.

One of the earliest studies to address biodiversity according to the value functions of the ecosystem is the study conducted by Costanza et al. (1997). Costanza et al. (1997) estimated the total value of 23 ecological functions to be $33 trillion/year for 17 ecosystems and 16 biomes through the use of various valuation techniques. It was estimated in the research conducted that, the value of the contribution of biodiversity to the nutritional cycle was $87 to 21,100/ha/year within the regulation function and it was foreseen the most important value element was medical resource value within the production function value category, which was 203 to $3,248/ha/year (Table 1). This shows that, species and genetic diversity constitutes a significantly potential value in terms of biodiversity. In addition, the value of recreation and eco-tourism, which are important value

Table 2. Ecosystem functions and service valuation.

Author	Value category	Study	Value ($)
Crossman and Bryan (2009)	Carbon regulation	15.8 million-ha study area agricultural areas of South Australia.	$ 6–120/ha/year
Crossman et al. (2011)	Recreation and amenity value	Australia	$ 1.5-10.2 /ha/year
Mullan and Kontoleon (2008)	Multiple Watershed services		From $ 200/ ha/year to $ 1,000 /ha/year
Brander et al. (2007)	Reef recreation		$ 184 per visit/year
Costello and Ward (2006)	Bioprospecting value		$ 14/ha -$ 65/ha
Ricketts et al. (2004)	Pollination service	Tropical forests for coffee production in Costa Rica	$ 361/ha/year
Kaiser and Roumasset (2002)	Watershed conservation	Mangroes and Wetlands in Malaysia and Hawaii	$ 845 ha /year-$ 1,022/ ha/year
Emerton (1999)	Water regulation/ Watershed conservation	Tropical forest in Mount Kenya	$ 273 ha /year
Laughland et al. (1996)	Water reserve value	Milesburg Pennsylvania	From $ 14 households to $ 36 households
Turner et al. (1995)	Life support value	Well-watered ecosystems, Swedish island	From $ 0,4 million to $ 2 million
Pina (1994)	Ecotourism value	Mexico	From $ 60/day to $ 100/ day

elements of information function, was estimated to be $3 to 6,000/ha/year (Table 1). The total of these values is defined as the maximization of social benefit obtained from biodiversity. The valuation studies in question allow for assessing and using biodiversity in an economically rational manner as well as better understanding the systematic relationships between the ecosystem functions.

The diversity which in the goods and services mobility of ecosystem provides the life support systems needed for living beings and thus, occurs a critical interdependence. This essential interdependence is the phenomenon underlying the sustainable development approach. This situation plays a vital role in the sharing of benefit and to be maximized for social benefits that are provided from the goods and services mobility of ecosystem. Mullan and Kontoleon (2008) calculated the value of the benefit obtained from various watershed services to be $200 ha/year and $1,000 ha/year. Costello and Ward (2006) evaluated bio-chemicals, natural medicine and pharmaceutics ecosystem service flows in tropical forests. Marginal value was estimated to range between 14/ha to $65/ha. Ricketts et al. (2004), calculated the pollination value for coffee production in tropical forests as $361 ha/year (Table 2). These figures indicate that, the transformation to the economic value of ecosystem services allows a clear link to the goods and service mobility of biological sources, and to the evaluation the ecological, the economic benefit and the benefit sharing processes. Thus, the profit and loss analysis is done correctly in these subjects. In addition, this research gives an evaluation of ecological destruction which in turn may cause potential losses to ecosystem services. Realization of this situation will create an awareness of the biological scarce resources which are providing positive added value and encouraging sustainable usage.

Evaluation of studies into genetic diversity and bio-prospecting

Bio-prospecting is generally defined as research conducted into the genetic codes of living organisms

Table 3. Value of bioprospecting agreements (Nunes and Schokkaert, 2003; Nunes and Nijkamp, 2011).

Parties	Study	Value
Novartis and Bioamazonia (2007)	10,000 samples of micro-organisms in Brazil	$ 4 million
Brazilian Extracta and Glaxo Wellcome (1999)	30,000 samples from special area of Brazil	$ 3,2 million
Yellowstone National Park and Diversa (1998)	Heat-resistant enzyme; Taq polymerase and bacteria; *Thermus aqyqticus*	$175, 000
Inbio and Merck (1991)	2,000 samples from genetic pool of Costa Rica	$1 million

(Ding et al., 2007). Genetic diversity which is the input of commercial products reflects the willingness of the drug industry to finance this research. Marginal value of such an input where genetic information is transformed for medical purposes corresponds to the added value that it brings to the development of health services (Ding et al., 2007; Costello and Ward, 2006). For instance, effective anti-cancer and anti-leukaemia drugs were discovered during research conducted on plants by the U.S. National Cancer Institute (Craft and Simpson 2001; Nunes et al., 2003).

Bio-prospecting agreements concluded between governments and drug industries imply the importance of financial indicators for such biodiversity values (Artuso, 2002). The most remarkable of these agreements was the incentive launched between Merck and Co. Ltd., the biggest drug company of the world, and Instituto National de Biodiversidad (INBio) in Costa Rica. When the contract was signed in 1991, Merck paid $1 000 000 and accepted to pay a royalty fee with the discovery of each new product. Subsequently, INBio Bristol-Myers Squibb signed contracts with other companies and non-governmental organisations obtaining genetic resources (Ten and Laird, 1999; Nunes et al., 2003; Ding et al., 2007; Costello and Ward, 2006). A similar agreement was signed between Diversa, a biotechnology company based in San Dieago, and the U.S. based Yellowstone National Park. Diversa accepted to pay $175,000 to Yellowstone to conduct bio-technological studies within national park spas on heat-resistant micro-organisms (Sonner, 1998; Macilwain, 1998; Nunes and Nijkamp, 2011). Likewise, Brazilian Extracta accepted to pay $3.2 000 000 to Glaxo Wellcome Company annually for 30,000 samples consisting of bacteria, fungi, and plants (Bonalume and Dixon, 1999; Nunes and Nijkamp, 2011) (Table 3). These agreements and the related studies indicate that, the economic value of genetic diversity is positive.

In the last century, biological genetic resources have become extremely popular with research and development laboratories in biotechnology for life science and medical companies. Companies, especially big multi-national corporations are forced to sign up to bio-prospecting agreements with many obvious benefits, such as the decrease of production process cost, the easy process of genetic material, the acceleration of production process, and buying power. Particularly, modern bio-technology organisms are not evaluated as a whole, only being evaluated down to the level of gene. It is remarkable that the willingness of the individual to pay (WTP) rise of bio-technology and medical companies for each gene source and process. From this perspective, all living organisms have an economic value and will be turned into a commodity. In this respect, gene diversity has created the added value and benefit economically. However, the WTP values of these companies have ignored the potential effect of genetic diversity in the new medicine and product development, in the use of plant and animal materials. The ethical values and indirect values of genetic diversity are not included in the market value of contracts. It would therefore be more realistic to interpret as the minimum of economic value of genetic diversity changing.

Case studies on biodiversity and species conservation

This study shows that, the economic value of species can be measured with all aspects. However, it is determined that, the study of species protection is perceived as a vital part of the forest ecosystems and wildlife ecosystems conservation and it is seen that, the economic valuation studies are limited solely to biodiversity. The limitation of these studies should be perceived as a big problem for the examination of biodiversity at the species level (single/multiple). This situation is made more difficult with the addition of value and indicator information, and understanding ecosystem processes and relationships with other species, the presentation of real economic value of biodiversity. This research has repeatedly stressed that, previous studies about this subject have been largely insufficient in their scope and conclusions. As research into the economic valuation of biodiversity goes into private biodiversity areas directly and looks at all factors and components

Table 4. Single species valuation in fauna diversity**.**

Author	Study	Average WTP calculations (household/year)
Stanley (2005)	*Streptocephalus wootoni*	$24,85
Bandara and Tisdell (2005, 2003) and Bandara (2004)	*Elephas maximus*	$ 1,94
Tisdell et al. (2005a, b)	*Petaurus gracilis*	$29.88
Tisdell and Wilson (2004)	*Dendrolagus bennettianus*	$53.10
Hsee and Rottenstreich (2004), Kontoleon and Swanson (2003)	*Ailuropoda melanoleuca*	$ 13.81
Horne and Pet¨ajist¨o (2003)	*Alces alces*	$145,49
Cicia et al. (2003)	*Equus caballus*	$33,89
Bosetti and Pearce (2003)	*Halichoerus grypus*	$12,83
Giraud et al. (2002)	*Eumetopias jubatus*	$73,83
Macmillan et al. (2002)	*Anser* sp	$11,91
White et al. (2001)	*Sciurus vulgaris*	$2,87
Bowker and Stoll (1998)	*Whooping crane* conservation	From $ 21 to $141
Stevens et al. (1997)	*Atlantic salmon* restoration in a river, Massachusetts	From $14,38 to $21,40
Jakobsson and Dragun (1996)	*Leadbeater's possum*, Australia	$ 29
Bostedt and Bomen (1996)	Wolf conservation in Sweden	From 700 SEK to 900 SEK
Loomis and Larson (1994)	*Gray whale* conservation, US	From $16 to $18
Loomis and Helfand (1993)	Conservation of different single species, US	$ 13 for sea turtles to $ 25 for *Bald eagle*
Van Kooten (1993)	Conservation of water bird's habitat in wetland, Canada	Sometimes from $ 50 to $ 60 (per ha)

influencing this subject, this insufficiency problem will be overcome.

As the economic valuation studies on plant and animal species are collated, it is seen that, the economic value studies are more focused on single animal species (Table 4), whereas single plant species studies have been more limited (Table 5). The studies listed with only one animal species evaluated are seen on Table 4. The calculations were derived from the contingent valuation (CV) practices and WTP) was determined to avoid the loss of some special species (Venkatachalam, 2004; Stanley, 2005). For instance, while Van Kooten (1993) calculated the WTP of a water bird living in a wetland in Canada to range between 50 and $60 per ha, Stevens et al. (1997) determined the restoration value of the *Atlantic salmon* living in a river in Massachusetts to range between 14.38 and $21.40. In the same way, Stanley (2005), calculated that for *Streptocephalus woottoni* WTP value is $24.85/year, Tisdell et al. (2005a, b), for *Petaurus gracilis* WTP value is $29.88/year and Tisdell and Wilson (2004), for *Dendrolagus bennettianus* WTP value is $53.10/year. It can be understood and seen from the given examples that, the protection value of single species as economical is very high in the fauna diversity.

Table 5 lists the economic valuation studies conducted on a single plant species. It is seen that, the economic valuation studies on single or multiple species of flora are limited both qualitatively and quantitatively in the flora diversity which form the first key stage of the ecological cycle. Besides, it is evaluated with goods and services as a source of timber within the forest ecosystems. This is derived from the complex structure of gene sources.

In studies where various analysis methods were employed, functional valuation of single species plant diversity was carried out. For instance, Lee (2002) analysed the value of orchid production in production farms in Taiwan through the method of production function and calculated a value of $112,615/year for each farmer. In Turkey, Demir (2009) calculated the total value for ecosystem functions of *Galanthus elwesii* as $68/per unit/year. The methods of market value, production function and conservation prevention cost were used in the analysis. Demir (2012) also calculated the medical resource value of summer snowflake in Turkey through the methods of production function and market analysis and estimated medical resource value as $4.5/per unit/year for each summer snowflake. When the social benefit to gain from the end product to be obtained with

Table 5. Valuation of single species in flora diversity**.**

Author	Study	Value
Demir (2012)	Medical value in summer snowflake, Turkey	$ 4,5/per unit/year
Demir (2009)	Total economic value of goods and services related to *Galanthus elwesii,* Turkey	$ 68 /per unit/year
Erdem (2006)	Conservation value of orchid, Turkey	$ 7 /household/year
Lee (2002)	Economic analysis of orchid production of Taiwan production plants, Taiwan	$377,231 / per farm/year and $112,615 /per farmer/year

Table 6. Studies on conservation of natural habitat and valuation of multiple species.

Author	Study	Average WTP Calculations (per household/year)
Aruoba (2007)	Value of Ecological Services of Yumurtalık Wetland, Turkey	$ 738 /ha/year
Başak (2003)	Tuz Lake Specially Protected Area, Central Anatolia, Turkey	$ 678,33/ha/year (Total value)
Turpie (2003)	Conservation of South African biodiversity, fynbos biome in the Western Cape, for national biodiversity	$ 8,4 million /year, $ 3,3 million/year,$ 58 million/year
Nunes (2002)	Conservation of natural parks and wilderness areas	From $ 40 to $ 51
Roosen et al. (2001), Région Wallonne (2001)	Conservation value for Rouge de *Belgique Cattle breeds* and 5 different sheep breeds, Belgium	€ 120 /Subsidy/animal/year and € 20 /Subsidy/animal/year
Wiestra (1996)	Conservation of ecological agricultural fields, the Netherlands	NLG 35 (single-limited)
Jakobsson and Dragun (1996b)	Conservation of all endangered species in	$118
Richer (1995)	Victoria Desert conservation in California	$101
Brouwer (1995)	Conservation of marshy pasture areas	From NLG 28 to NLG 72
Carson et al. (1994)	Kakadu conservation region and natural park conservation, Australia	$ 52 (little influence scenario) $ 80 (big influence scenario)
Hoevenagel (1994)	Improving wild life habitat in marshy pasture areas in Germany, the Netherlands	From NLG 16 to NLG 46
Desvousges et al. (1993)	Conservation of immigrant water birds in Central Flyway	From $ 59 to $ 71
Whitehead (1993)	Nongame wild life conservation program	$ 15
Duffield and Patterson (1992)	Fishery conservation in Montana Rivers	From $ 2 to $ 4 (for the residents), from $ 12 to $17 (for nonresidents)
Halstead et al. (1992)	Conservation of bald eagle, jackal and wild turkey in England	$ 15

the processing of these plants is included in these values, the resulting added value will be even higher. The increase in the quality and quantity of studies of this area will be a guide to a more holistic understanding of the roles of plant species within an ecosystem.

Case studies on conservation of natural habitat and on evaluation multiple species

Some studies prefer associating the value of biodiversity to the value of conservation of natural habitat. Case studies conducted in this respect are given in Table 6. For instance, Nunes (2002) conducted the first national CV application in Portugal, carried out a WTP evaluation for the conservation of natural parks and wilderness areas and obtained an average WTP ranging between 40 and $51. Besides, a CV study was conducted by Bateman et al. (1992) to evaluate the financial value of conserving the Norfolk Broads. The results showed that, the residents of the Norfolk Broads had a WTP value of

£12 while those living in different regions of UK had a WTP value of £4 (Table 6). Hoevenagl (1994) carried out a WTP research by telling 127 farmers in the pasture areas in Germany that they would receive grants from the government on condition that they used their fields in a manner benefitting the habitat of wild animals. The assessment revealed an average WTP ranging between NLG 16 and NLG 45. Kealy and Turner (1993) calculated the WTP value of the benefit obtained from conserving Adirondack aquatic system to range between 12 and $18. Siberman et al. (1992) examined the current value of coast ecosystems for users and non-users of New Jersey coasts. The average WTP was found as $15.1 for users while it was found as $9.26 for non-users. Lastly, Halstead et al. (1992) calculated the WTP value for conserving *Bald eagle*, jackal and wild turkey in New England as $15.

When comparing multi-species and single species research, multi-species WTP values are significantly higher. The problem in the value account interpretation of species or habitat conservation is the missing connection between a special species or habitat and habitats in need of conservation. This is the primary difficulty in the economic value analysis of species and habitats.

Conclusion

In this study biodiversity was analyzed at different levels: the ecosystem and its functions, genetic diversity and bio-prospecting, species and habitats showing that, biodiversity should be evaluated using an interdisciplinary approach. In this way, biodiversity has been formulated with the other different components and has been transformed to an economic value using the various valuation methodologies.

In addition, the economic value of biodiversity is Affected and changed according to the level of diversity in habitat, the type of value, the applied valuation method, the geographic location and socio-economic structure.

The main question which needed answering through this research was ‘how can we use the present research to formulate an integrated and effective framework to determinate the value of biodiversity?’ The answer to this question requires that, a clear life diversity level be chosen, a concrete biodiversity changing scenario to be formulated, the biodiversity within certain boundaries, and at last, having a particular perspective on the value of biodiversity. It was shown that, most economical studies, using the monetary valuation have actually confused biodiversity with biological resources. This situation has lead to a dearth of studies focused principally on biodiversity. Additionally, it seems clear that in our assessment of economic valuation studies, the evaluation of biodiversity values does not give a stable or clear monetary value for biodiversity. Therefore, it should be accepted that, the economic valuation studies have an inadequate perspective for the unknown value of biodiversity changes and obtained economic values and indicators are considered as a lower limit.

To reiterate, the economic valuation estimates should be regarded as providing a very incomplete perspective on, and at the best lower bounds to the unknown value of biodiversity changes. However, it should be given a place to “the integrated ecological and economic models”. The integrated models can bring out several biological and economic (possibly monetary) indicators which are collected via the multi-criteria analysis techniques. It is possible to provide for a closer, innovative connection between modelling and valuation, among other methods, by generating conditional values for specific environmental-economic scenarios; using scenario-modelling outcomes such as tables and graphs in valuation experiments (e.g., contingent valuation) and using spatial models to aggregate monetary values related to specific areas.

To date, most studies lack a uniform and clear perspective on biodiversity as a distinct, univocal concept. This situation is explained by many reasons. First reason is that, insufficient information exists on the quantity of species and the genetic variations within species. Secondly, it is not known exactly the population analysis and the genetic variation value of species in a population. Thirdly, the numerous functions among ecosystems and the value of interrelation diversity that occurs in the different ecosystems have not been fully taken into account. Finally, the significant differing degree in the similar assets on the global level, the biodiversity values because of the unequal international income distribution. In order to determine unequivocally the total economic value of biodiversity, we should remove these obstacles.

In conclusion, the available economic valuation estimates should be considered, at best, as a lower bound to an unknown value of biodiversity, and are always contingent upon the available scientific information as well as their global socio-economic context. As we have seen, biodiversity can be dealt with at different levels: genetic, species, ecosystem, and functional diversity. For the analysis and valuation of biodiversity at the ecosystem and functional levels, which may be regarded as the cornerstone of the analysis and valuation of biodiversity, an active interdisciplinary dialogue is necessary, with emphasis on the complex interface between natural science and social science disciplines.

A comprehensive assessment of ecosystem biodiversity characteristics, structure, and functioning requires the analyst to take various important steps. Firstly, the socio-economic causes and consequences of biodiversity degradation or loss should be determined. Secondly, the negative impacts on biodiversity caused by human activities should be assessed. The range and degree of biodiversity functioning should be estimated, especially in terms of ecosystem-functional relationships. Finally, alternative biodiversity management strategies should be ranked and a joint spatial and temporal systems analysis of each policy scenario should be undertaken. However, the physical assessment of the functions performed by biodiversity is an essential prerequisite to any ecological evaluation. Thus, simply identifying functions will be insufficient if we want to present resource managers and policymakers with relevant policy response options. Valuation criteria for the function evaluations of species such as computer modelling, geographical information systems (GIS), Red Data Species Lists and the biological value indexes must be further developed. This in turn will lead to evaluations in terms of the value of biodiversity, providing input to the production process, the effects on the regulation of human welfare and ecological functions. This approach to ecological evaluation allows for a direct comparison of management or conservation strategies.

Economists, the ecologists, and other vested interests must work together using integrated approaches for a clearer understanding of the importance of these studies. Only in this way can we expect full social benefit-sharing, together with effective and useful policy implementation. The significance of these studies is far greater for those responsible countries that strive to protect the rich biological diversity that remains.

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