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Ecosystem and Species Appreciation – Service Flow, Biodiversity Wealth and Biodiversity Debt *

(* This article is an update and extension of chapter 5.2.4 “ES for biodiversity conservation” in Grunewald et al. 2021)

Problem and objectives

The Common International Classification of Ecosystem Services (CICES 5.1, EEA 2020) defines the cultural ecosystem service 3.2.2.1. belonging to “non-use values” as “Characteristics or features of living systems that have an existence value”. The “simple descriptor” for this service states: “The things in nature that we think should be conserved”. In a similar way, service 3.2.2.2 is defined for features that have a “bequest value” and should be conserved for the use or enjoyment of future generations. Example services of 3.2.2.1 and 3.2.2.2 are “Areas designated as wilderness“ and “Endangered species or habitat“. In SEEA EA (2021: 6.5.1) the correspondent service is called “Ecosystem and species appreciation”.

Though, SEEA-EA (2021: 6.7.2, 6.7.3) generally accepts this as an ecosystem service, there is, however, a principle difference seen to other services like for instance visual amenity services. Because by definition there is no need for a physical transaction between ecosystems and individuals - except information flows - to gain benefits from “Ecosystem and species appreciation” services. SEEA EA therefore speaks of well-being induced by that service instead of benefits. Nevertheless, SEEA EA also sees a clear political demand for a monetary valuation of this service e.g. in the framework of complementary valuations (SEEA EA Chapter 12).

The SEEA EA proposals for the monetary valuation of ecosystem services do not yet have the status of an international standard. In our view, the methodology for monetary valuation proposed here would be applicable both within the framework of a regular monetary ecosystem account (SEEA EA Chapter 9) and within the framework of the complementary valuation under Chapter 12.

Physical assessment – methodology, data and results

The method that was applied for the physical and monetary assessment of appreciation services used the so-called “biotope points” as the basis for calculation. Biotope points take into account ecosystem characteristics such as naturalness, age, the occurrence of endangered species or the degree of threat to the ecosystem type itself. They are widely employed in Germany to determine the no-net loss under nature conservation law when impacts on biological diversity need to be offset by the upgrading or development of new habitats (OECD 2016). Biotope points can thus be regarded as physical exchange values for ecosystems.

The ordering of the biotopes within the applied value scale is very similar to the ordering of biotopes resulting from the application of scientific concepts of human influence (hemeroby) or so-called degrees of naturalness. Furthermore, even in countries where compensation for

impairments to nature and landscape is not prescribed, there exist procedures for the comparative assessment of different biotopes, e.g. when optimizing the choice for development sites or transport networks. It is therefore likely that comparable rating scales can be agreed upon also in other countries.

We have adopted the biotope point list of Mengel et al. (2018) prepared for the Federal Compensation Ordinance (BKompV 2020). This list defines average biotope points for about 500 different ecosystem types. The assessments range from 0 (pavements) to 24 (healthy bogs, old (semi-) natural forests). The listed points are considered to be average values that can be increased or decreased by a maximum of three points to reflect specific conditions.

To monitor the extent and current state of the ecosystems, data from various sources has been integrated into a coherent system for long-term analysis (Grunewald et al. 2020, 2021):

- the satellite data based German Land Cover Model LBM-DE (BKG 2020), which is compatible with the Corine Land Cover data,
- data on land use and agricultural land use from the Federal Statistical Office (StBA 2020 a, b),
- line based cadastre data like for hedges, tree rows, streams, paths and the traffic network,
- the Federal Forest Inventory (BMEL 2020),
- data from the reporting on the European Habitats Directives (BfN 2020a), Water Framework Directive (UBA 2020) and Marine Framework Strategy Directive (
- Monitoring of High-Nature-Value farmland (BfN 2020b).

With the help of these sources, areas were defined for about 300 different ecosystem types including ecosystem condition classes, covering the entire territory of Germany.

A certain biotope point value per hectare could be assigned to each of these types. The sum of all biotope values in a certain accounting year can be seen, on the one hand, as a physical measure for Germany´s wealth of biodiversity in that year and, on the other hand, also as a physical measure of an implicit flow of appreciation of ecosystem and species services to people during that year. This flow is called implicit here, because – as already said - the well-being effect ecosystem and species services have, is based on information rather than on transactions in the sense of SEEA EA.

Between 2012 and 2018, the biological diversity in Germany determined by means of biotope points first fell from 420.1 Mio. points in 2012 to 415.6 Mio. points in 2015 and then increased again slightly to 415.7 Mio. points in 2018. The change from 2012 to 2015 can be caused through methodological changes in the data base. The increase from 2015 to 2018 is too small to derive a positive trend. In 2018, Annex I habitats of the European Habitats Directive and so called High-Nature-Value farmland accounted for 18.2 % of Germany’s land area as against 31.2 % of total biotope points.

For the physical assessment of biodiversity wealth, only such data and information were used that can be linked to information on the costs of developing biotopes for the subsequent purpose of monetary valuation. The condition and biodiversity accounts still to be carried out will go further and consider also directly species-related data, among other things.

Monetary assessment of biodiversity wealth and implicit service flows from biodiversity

In order to calculate the monetary value of the entire biodiversity stock measured with the above methodology, the average costs for the production of a single biotope point were estimated. Ideally, one would use real costs of compensation measures or market prices of providers of compensation biotopes for this purpose, which would be nearest to exchange values preferably used in accounting. Unfortunately, however, such data are not available in a representative manner for Germany. For this reason, average costs per biotope point were estimated on the basis of the expected costs of the habitat restoration measures that will be required in the coming years to meet the obligations of the EU Habitat Directives (LANA 2016).

The method applied to determine average cost to reach an additional biotope point combines accounting methods to estimate values for real estate on the basis of construction cost (ImmoWertV 2019, Art. 22) with elements from Habitat Equivalence Analysis (NOAA 2020), which is used to determine compensation for ecological damage. The method takes into account the time needed for each ecosystem to reach the targeted condition. This is done by assuming a linear development of an ecosystem during development time and discounting this development to a present value (Schweppe-Kraft 1998, 2009). The discount rate used was 3%. Applying this method, the average cost per an additional biotope point was estimated at € 3,634.

For individual restoration measures, the costs per biotope value point were in part significantly higher than this figure. So one could argue that € 3,634 is not equivalent to a price for it does not express the quite higher marginal utility than rather an average utility. However, politicians who decide on the funding of programmes usually do not consider the cost-benefit ratios of each individual programme component, but rather have the cost-benefit ratio of the overall programme in mind when making their decision. We therefore believe that the calculated average cost rate is not only an estimate of the mean cost per additional biotope value point, but can also be seen as a value for the marginal social willingness to pay per biotope value point.

Assessments based on two contingent-valuation studies (Meyerhoff et al. 2012, Hampicke et al. 1991) on the willingness to pay for nationwide nature conservation programmes show values per biotope point that are about twice as high as the values calculated using the above outlined cost approach. As the effects of the mentioned programmes are quite relevant but marginal compared with the total biodiversity in Germany, we can assume that the willingness to pay per biotope point is a proxy for the marginal willingness to pay. The results of the cost approach can therefore also be taken as a conservative lower bound estimate of the individual marginal willingness to pay for an additional biotope point.

Applying the above cost rate to the total sum of biotope value(point)s in Germany, the monetary value of the entire stock of biodiversity in Germany – here referred to as Germany's biodiversity wealth - is estimated at €1,408 billion in 2018 (state of calculation February 2021). This is more than the value of productive capital in Germany excluding buildings, estimated at €1,395 billion in 2018 (Destatis 2020c). Assuming that invested capital is expected to earn a 3% return, the implicit annual services of biodiversity in favour of human well-being could be attributed an annual income equivalent of €45.3 billion which is €1,095 per household and year.

Calculating an ecological debt

The method described above can also be used to calculate Germany's ecological debt with regard to the current state of biodiversity. To do this, it is necessary to first define a desired reference state of biodiversity, then express this in biotope value points and finally evaluate it in monetary terms using the same cost rate as above. The difference between the value of the desired status of biological diversity and the status currently achieved is then the amount of ecological debt that results from the deviation from the target value.

So far we have only calculated this debt in relation to the failure to achieve the objectives of the European Habitats Directive. The difference between the biodiversity wealth when the guidelines are fully met and the current situation was estimated at about €60 billion, depending on the precise definition of the target situation.

A comparison of SNA and non-SNA-values regarding biodiversity conservation and ecosystem and species appreciation

Fig. 1 compares the value found for biodiversity wealth with that calculated for the biodiversity debt. It becomes clear, that the debt is only a fraction of the current wealth. At first glance this seems reassuring.

However, we need to realise that both quantities are linked in very different ways to the social and natural conditions of production. Biodiversity wealth is largely provided free of charge by nature, while biodiversity debts have to be reduced through the use of capital and labour. Furthermore, some biodiversity debts can be irreversible, especially in the case of species extinction.

The extent of the current difference between services provided free of charge by nature and the state's contribution to biodiversity conservation is illustrated in Figure 2. Again, the monetary value of implicit annual ecosystem services for ecosystem and species appreciation is many times higher than the government's expenditure to maintain these services.

Figure 1:

Biodiversity wealth and biodiversity debt by 2018
(billion Euros)

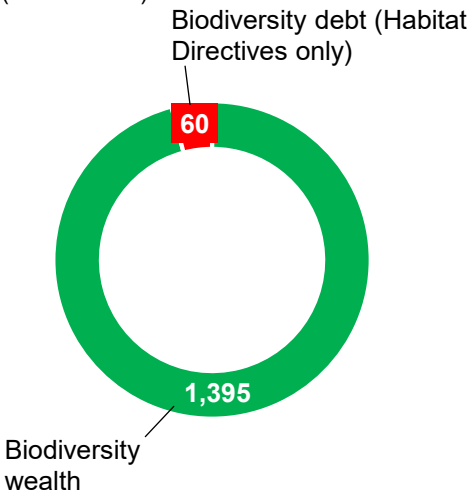
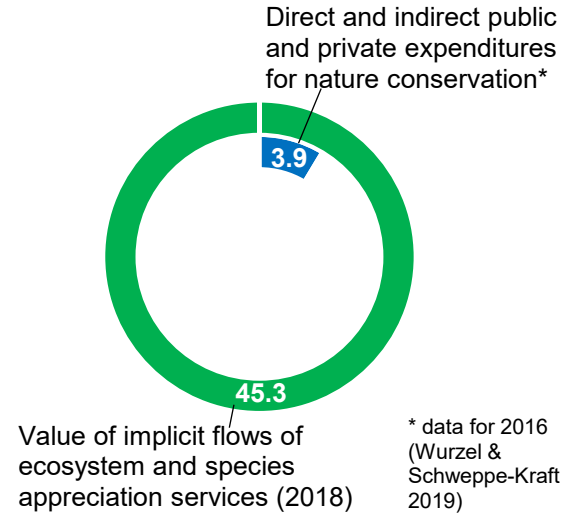


Figure 2:

Biodiversity and biodiversity conservation - implicit service flows and expenditures
(billion Euros per year)



Next steps for further refinement and expected results

In a next step, we will apply the final of the Compensation Ordinance instead of the proposal of Mengel et al. (2018). This final list is even more detailed, especially with regard to marine and coastal ecosystems and includes also some small changes in values. Regarding the total value for both, biotope point values and monetary value of biodiversity we expect only marginal deviations from the current results.

In addition, we will apply a different method to calculate the condition of habitats protected by the European Habitat Directives. The method currently applied, takes the conservation status of a certain habitat type as a proxy for the condition of all areas of this ecosystem type. This, however, leads to an underestimation of the average condition of an ecosystem type. In the next assessment we will instead use more detailed area specific data on the condition of protected habitats. This will lead to higher values for protected habitats and to a smaller biodiversity debt with regard to the targets of the European Habitat Directives.

Conclusions and outlook

Biodiversity loss is often considered one of the most important current environmental problems, along with climate change. However, at least for Germany, but probably also for all other industrialised countries, the following is true: the government and private spending required to ensure successful biodiversity conservation – e.g. €1.4 billion per year to reach the goals of the European Habitat Directives in Germany (LANA 2016) – is marginal compared to other economic activities.

An environmental accounting that looks at the problem of biodiversity conservation only from the expenditure and production side will therefore only provide very small figures.

The new SEEA EA, on the other hand, opens up the opportunity to include nature's services outside the production boundary. In this way, the sector ”ecosystems and species conservation” within the environmental economic accounts can become a size that makes it recognisable also in monetary terms as soon as also the “ecosystem and species appreciation services” are taken into account on a monetary basis. This would correspond with the already existing political importance of this sector.

In order to achieve this goal, standards must be developed in the future to be able to express also the nature-born value of ecosystem and species appreciation services in monetary terms; either as part of the core accounts or as part of the complementary valuations.

The concept for the valuation of biodiversity wealth, biodiversity debt and implicit monetary service flows presented provides a simple and practical proposal for a first step to achieve this aim.

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