Paper

Publishing and interpreting data from the monetary SEEA Ecosystem accounts

Eurostat grant project 2023

Sjoerd Schenau,
Redbad Mosterd

March 2024

Contents

1. Introduction

The System of Environmental and Economic Accounting – Ecosystem Accounts (SEEA EA), adopted by the UN Statistical Commission in March 2021, provides internationally recognized statistical principles and recommendations for the valuation of ecosystem services and assets in a context that is coherent with the concepts of the System of National Accounts (chapters 8-12; UN, 2021). In SEEA EA, a key purpose of valuing ecosystem services and ecosystem assets in monetary terms is the integration of information on ecosystem condition and ecosystem services with information in the standard national accounts. This enables comparison of the supply and use of ecosystem services with the production and consumption of other goods and services. Additionally, it supports the use of ecosystem information in standard economic modelling and productivity analysis.

In 2024 Regulation (EU) No 691/2011 on environmental accounting will be extended with an amendment on Ecosystem accounts. The amendment focusses on the extent account, condition account and supply and use tables for ecosystem services in physical terms. Although monetary ecosystem accounts will not become part of the extension of the legal base, text is included that the Commission may supplement this Regulation with monetary accounts by means of a delegated act.

Among statisticians and more broadly, the use of monetary values of environmental stocks and flows in the measurement and assessment of the environment has long been a point of discussion and contention (UN, 2021). Besides various remaining methodological and compilation issues, a key challenge is determining how to present the results to users and how to interpret them. Valuation of ecosystem services and assets represents a special kind of data, which requires careful consideration with regard to its dissemination. Results can easily be misinterpreted, misused or ignored (being too complex to put into use). For example, a particular method may suggest that the economic value of an ecosystem service is low, zero or negative. It would be irresponsible to conclude that the ecosystem service and the associated asset truly have no value. This is particularly relevant when the resulting values are used to compare alternatives in policy decision making.

Statistical institutes thus must take extra care when compiling and publishing these results. This is also a key reason why statistical offices are often hesitant to start the compilation of the monetary SEEA EA accounts. There is a clear need to provide more guidance on how to interpret and publish these data. Therefore, the **primary objective of this report is to clarify how the results of the monetary ecosystem accounts are best interpreted and disseminated for statistical purposes**. This will be done by taking the results of the Dutch ecosystem accounts as an example.

The report builds upon previous work carried out on ecosystem accounting in the Netherlands (Statistics Netherlands and WUR, 2020; Hein et al., 2021). In 2016, Statistics Netherlands and Wageningen University started the implementation of SEEA EA for the Netherlands on behalf of the Ministry of Agriculture. The overall aim was to test and implement SEEA EA ecosystem accounting on a national scale, including the monetary ecosystem accounts. During the last years, the monetary physical supply and use tables (PSUTs) and asset account have been compiled for 2013-2020. The methodology and results have been published in several background reports (e.g. Statistics Netherlands and WUR, 2023).

In chapter 2 a short overview is provided of the monetary SEEA EA accounts and their key indicators. In chapter 3, the methods and results of a decomposition analysis for ecosystem service values is presented. The results of this decomposition analysis may help to better understand what changes in value over time are actually telling us. Chapter 4 provides a broad overview on how compilers can best present and interpret the data on monetary ecosystem values to users, taking data from Netherlands as an example. Finally, in chapter 5 we will conclude and provide some general recommendations.

2. The monetary SEEA EA accounts and their key indicators

2.1 Short description of ecosystem valuation and the monetary SEEA EA accounts

The SEEA EA is a statistical system designed to create an integrated and internally consistent series of accounts, offering a comprehensive and well-structured view of ecosystems (UN, 2021). Within the ecosystem accounting framework, ecosystem services serve as the vital link connecting ecosystem assets to the productive and consumptive activities of businesses, households, and governments. SEEA EA defines ecosystem services (ES) as **the contributions of ecosystems to the benefits that are used in economic and other human activity**. By recording flows of ecosystem services, the SEEA EA extends the so called SNA production boundary, i.e. measurement scope of goods and services recorded in the SNA. The accurate measurement of ecosystem services is central to presenting a fully integrated suite of ecosystem accounts.

In the SEEA EA, ecosystem services and ecosystem assets are quantified in both physical and monetary terms. A key benefit of employing a uniform monetary unit or numeraire is the capacity to create uniform comparisons among different ecosystem services and assets (UN, 2021). This consistency harmonizes with the established metrics used for products and assets in national accounts. This harmonization necessitates the incorporation of **exchange values**, which, in turn, facilitate the development of an integrated framework for pricing and quantification. This integration is in line with a core objective of the SEEA EA, facilitating a comprehensive perspective on the relationship between the economy and the environment.

Exchange values are the values at which goods, services, labour or assets are in fact exchanged or else could be exchanged for cash. (2008 SNA, par. 3.118). In an ecosystem accounting context, exchange values are those values that reflect the price at which ecosystem services and ecosystem assets are exchanged or would be exchanged between willing buyers and sellers if a market existed (UN, 2021). Since the ecosystem assets themselves are not actual market participants, the challenge in valuation lies in establishing the assumptions about the institutional arrangements that would apply if there was an actual market involving ecosystem assets. A further distinction can be made between a) exchange values already captured in the SNA production boundary, but not recognized as such (for example the values for most provisioning services), and b) exchange values captured in the SEEA EA extended production boundary (for example health benefits from ecosystems or carbon sequestration), see Figure 2.1. Exchange values are of interest because they allow direct comparison of values of ecosystem services and assets with existing national accounting values. Therefore, this is the recommended approach to apply in SEEA EA (UN, 2021).

Welfare economic values entail obtaining valuations that measure the change in the overall costs and benefits associated with ecosystem services and assets (UN, 2021). Welfare values are often related to changes in the sum of the producer and the consumer surplus. It includes so-called consumer surplus is, i.e. the monetary gain obtained by consumers because they are able to purchase a product for a price that is less than the highest price that they would be willing to pay. Welfare values are most commonly used in economic and environmental cost-benefit analysis where the focus is on the impacts of various policy choices on economic outcomes that are of common interest. The SEEA EA acknowledges the significance of the welfare valuation approach in informing decision-making within public policy. This is particularly evident in scenarios such as the evaluation of costs and benefits associated with additional investments in regional planning. However, for reasons explained above, the current focus of the SEEA EA is on producing estimates in exchange values.

Finally, **intrinsic values** refer to inherent value, that is the value that something has independent of any human experience or evaluation. By definition, intrinsic values cannot be captures in monetary terms.

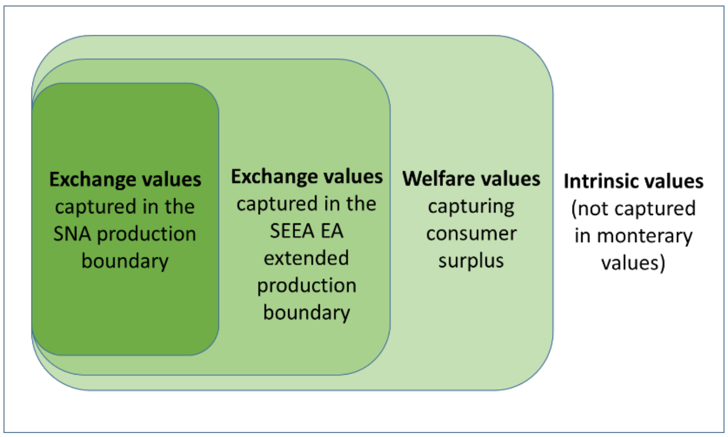

Figure 2.1 Different value concepts recognized within the SEEA EA framework

Several **valuation techniques** are available to value the different ecosystem services. SEEA EA does not proscribe any particular method, they can be applied as long as they are based on exchange values[1]. For an overview of possible methods see SEEA EA chapter 9 and Monetary valuation of ecosystem services and ecosystem assets for ecosystem accounting (NCAVES and MAIA,2022).

The value of an ecosystem assets can be derived using the net present value approach. In ecosystem accounting, an ecosystem asset generates a bundle of ecosystem services, each valued separately. The NPV formula is applied at the level of individual ecosystem services and the resulting discounted values are aggregated to derive the monetary value of the ecosystem asset (SEEA EA par. 10.45). This approach requires assumptions about the future flows of income, as well as about the discount rate used to convert the future income to current values and the corresponding time horizon.

Monetary ecosystem values are integrated into several dedicated monetary accounts. These monetary accounts play a key role in unraveling the economic aspects of ecosystem services and understanding

[1] Although many different valuation methods can be applied, there is a strong preference in SEEA EA for using methods that translate observable and revealed prices and costs into the values required for accounting purposes.

their substantial contributions to the well-being of society and the broader economy. The main monetary ecosystem accounts encompass:

- **The ecosystem services flow account in monetary terms** that records the supply of ecosystem services by ecosystem assets and the use of those services by economic units, including households (See SEEA EA Chapter 9 for more information).
- **The ecosystem monetary asset account** that records information on stocks and changes in stocks (additions and reductions) of ecosystem assets. This includes accounting for ecosystem degradation and enhancement (see SEEA EA Chapter 10 for more information).
- **The extended sequence of accounts** that integrates the value of ecosystem services and degradation/enhancement in the full sequence of national accounts, allowing derivation of adjusted aggregates for production, income and savings (See SEEA EA Chapter 11 for more information).

2.2 Monetary ecosystem indicators

Monetary indicators play a crucial role in the field of ecosystem accounting, offering a quantitative approach to assess the economic value of ecosystems and their contributions to society and the economy. Traditionally, efforts have revolved around assigning values to individual ecosystem services, however there is a growing need to develop aggregate indicators that consolidate these valuations, thereby addressing the need for a comprehensive overview. Indicators allow decision-makers to focus on specific ecosystem services that are of particular importance or concern in a given context. Indicators help us share complex data in a simple way, making it easier to understand. These indicators bridge the gap between economic and ecological considerations by translating nature's benefits into monetary terms, equipping decision-makers with the tools needed to evaluate trade-offs and make well-informed choices. An overview of the key monetary indicators from the SEEA EA is shown in table 2.1.

Table 2.1: Potential indicators on monetary ecosystem services flows account and ecosystem asset accounts

Monetary indicators	Further description	Spatial unit	Disaggregation	Unit of measurement
Gross Ecosystem Product (GEP)	The economic value added of all ecosystem services generated	Ecosystem accounting area	Ecosystem type, ecosystem services classes	Local currency
GEP as a percentage of GDP	Contribution of ecosystems to total economic activities	Ecosystem accounting area	Ecosystem type, ecosystem services classes	Percentage
Value of ecosystem services linked to industry value added	Value added of industries with direct inputs of ecosystem services	Ecosystem accounting area	Ecosystem type	Percentage
Total ecosystem asset value (TAV)	End of year monetary ecosystem asset value	Ecosystem accounting area	Ecosystem type	Local currency

Total ecosystem asset value (TAV) as a percentage of total national wealth	Ecosystem asset value as a percentage of total national wealth	Ecosystem accounting area	Ecosystem type	Percentage
Cost of degradation	Reduction to addition of monetary ecosystem asset value attributable to ecosystem degradation	Ecosystem accounting area	Ecosystem type, per capita by administrative areas, planning areas	Local currency

Gross Ecosystem Product (GEP) is calculated as the sum of all final ecosystem services at their exchange value provided by all ecosystem types within an ecosystem accounting area over an accounting period. It is adjusted by subtracting the net imports of intermediate services (SEEA EA par. 9.18). In cases where the net imports of intermediate services (i.e., imports minus exports of intermediate services) are negligible, GEP may be approximated as the sum of final ecosystem services supplied by the ecosystem accounting area (EAA). GEP as an indicator summarizes the value that ecosystem services provide to society annually as a single monetary metric for a certain area (Ouyang et al., 2020; Zheng et al., 2023). GEP thus helps policymakers and economists to recognize the substantial contributions of nature to human well-being and the economy. Additionally, expressing the Gross Ecosystem Product (GEP) as a percentage of the Gross Domestic Product (GDP) can provide insights into the relative economic significance of ecosystem services within a country or region. We will come back to this in chapter 4.

At the regional and local scale, GEP can be a powerful tool for assessing the economic contributions of ecosystems to specific regions, such as provinces or local municipalities. When GEP is calculated and analyzed at this level, it provides valuable insights into the unique ecosystem services and economic dependencies of the area in question. For instance, in the Netherlands the accounts also include monetary values of ecosystem services at the province level, and accordingly GEP data on this level can help local policymakers and stakeholders to make informed decisions about resource management, land use planning, and conservation efforts tailored to their specific environmental and economic context. This localized application of GEP helps to bridge the gap between national-level policy objectives and the intricacies of regional ecosystems.

The **Total (Ecosystem) Asset Value (TAV)** represents the aggregated value of a region or country's natural assets, including its various ecosystems, and is part of broader efforts to recognize the economic significance of natural resources and natural capital. The TAV represents a long-term value, providing an estimate of the cumulative worth of natural assets over time. It doesn't typically change rapidly from year to year. This is different from the GEP which is an annual flow measure, reflecting the economic value of ecosystem services for a specific accounting period (usually a year).

Cost of ecosystem degradation is the decrease in the value of an ecosystem asset over an accounting period that is associated with a decline in the condition of an ecosystem asset during that accounting period (SEEA EA par. 10.21). This indicator thus reflects the loss of value of ecosystem capital due to a decrease of ecosystem quality.

Examining indicators in monetary terms, along with the physical indicators, provides a well-rounded view of the connection between nature and the economy. Monetary indicators put a price tag on the benefits we get from nature, like clean air or crops, making it clear how they support our economy. On the other hand, physical data tell us if ecosystems are in good shape, which matters for their ability to provide those benefits. This two-sided approach helps decision-makers balance economic growth with environmental protection and understand where we might need to make trade-offs to safeguard nature. For example, the condition account looks at the quality of ecosystems in physical terms, helping us assess how healthy they are and if they can keep delivering the services we rely on.

3. Decomposition analysis

3.1 introduction

Decomposition analyses allow identifying the main drivers of observed changes over time of a certain variable. A well-known example is the decomposition analyses for CO_2 emissions, where the change in emissions is explained by changes in economic production, energy mix and energy use. Such decomposition analyses fall under two distinct but related categories: index decomposition analysis (IDA) and structural decomposition analyses (SDA). In index decomposition analysis the link between impact (such as energy, environmental employment) and production level is explored. In structural decomposition analysis the link between impact and consumption activities is explored. Hence, SDA is more comprehensive than IDA (since it requires explicitly accounting for the link between production and consumption) but also requires more data (De Boer and Rodrigues, 2020).

In the SEEA EA, decomposition analysis has been used to analyze the changes in monetary asset values in order to derive the accounting entries for the monetary asset account (see Annex 10.1 of the SEEA EA). In principle, the same decomposition analysis can also be applied to monetary ecosystem service values, i.e. to explain changes in ecosystem service values in time. In this section we will discuss the methodology and present results of this analysis. In chapter 4 the results will be used to support the interpretation of changes in monetary ecosystem values over time.

3.2 Methodology

Monetary values for ecosystem services can be decomposed in the following three elements:

1. **Area effect:** the change in the value that can be related to changes in area. For example, if the area of forest decreases due to deforestation, it is to be expected that the value of ecosystem services provided by the forests will also decrease.
2. **Volume effect:** the change in the value that can be related to changes in volume. In accounting, volume reflects the combination of quantity and quality. Volume changes can thus have several causes, including changes in demand and changes in ecosystem condition.
3. **Price effect**: the change in value that is related to changes in prices. For example, if the carbon price used to value carbon sequestration increases this will increase the value for this service.

Basically, the change in monetary value of the ecosystem services (dV) can be expressed with the following formula:

$$dV = dA * dF/A * dV/ F$$

where:

dA is the change in area of the ecosystem assets

dF/A is the change of the physical flow of the ecosystem service per hectare

dV/F is the change in the relative price of the ecosystem service

Accordingly, this decomposition analysis allows the identification of three effects. In addition, as we will discuss below, it is useful to separate positive and negative volume effects[2]. For a more elaborate description of the technical details for the decomposition analysis we refer to SEEA EA annex 10.1: Application of the net present value method for valuing ecosystem assets and changes.

We have applied the decomposition analysis to analyze the changes in ecosystem service values that occurred between 2013 and 2021 (the first and last year for which data is currently available). The final ecosystem services that have been analyzed for the Netherlands are listed in table 3.1. Note that for nature recreation and nature tourism a further disaggregation has been applied. In monetary terms these are significant ecosystem services, making it worthwhile to apply a more detailed analysis.

Table 3.1 Overview of the ecosystem services that have been included in the Dutch ecosystem accounts

Provisioning services
Crop provisioning
Grazed biomass provisioning
Timber provisioning
Regulating services
Drinking water filtration
Air filtration
Carbon sequestration in biomass and soil
Carbon retention
Pollination
Coastal protection
Cultural services
Nature recreation
Hiking
Cycling
Other outdoor recreation
Touring by car / motor
Outdoor sports (incl. watersport)
Nature tourism
Nature tourism: residents
Nature tourism: non residents
Other expenditure
Amenity service

[2] On the most detailed level (i.e. for a specific ecosystem service and a specific ecosystem type) the decomposition analysis provides a positive or negative volume effect. When aggregated for the total of an ecosystem service or the total of an ecosystem type, positive and negative volume effects may be separately accounted for.

The source data needed for this analysis are a) monetary values for the ecosystem services by ecosystem type (monetary supply and use tables), b) physical data for ecosystem services by ecosystem type (physical supply and use tables), and c) areas for the different ecosystem types (extent account). The methodologies for calculating these source data can be found in background documents on the Dutch ecosystem accounts (Statistics Netherlands and WUR, 2023).

The decomposition analysis has been calculated in Excel. For each ecosystem type the decomposition is calculated for the different ecosystem services in separate excel sheets. Accordingly, values can be decomposed on the level of a) ecosystem types, b) ecosystem services, b) the total ecosystem accounting area, in this case the total of the Netherlands.

3.3 Results

For the presentation of the main results we will follow a top down approach: we start with the results for the whole country, then zoom in to the specific ecosystem services and ecosystem types.

Total value of ecosystem services

The value for the total supply of ecosystem services (GEP) increased with 5444 million euro (in current prices) between 2013 and 2021. This increase can largely be accounted for by an increase in the prices for ecosystem services (3751 million euro). The total volume effect is also significant (1715 million euro), whereas the total area effect (21 million euro) is small. The underlying volume effects show both a high positive contributions (2542 million euro) and high negative contributions (-828 million euro). From this we can thus also deduce the increase of GEP in constant prices, namely 1693 million euro.

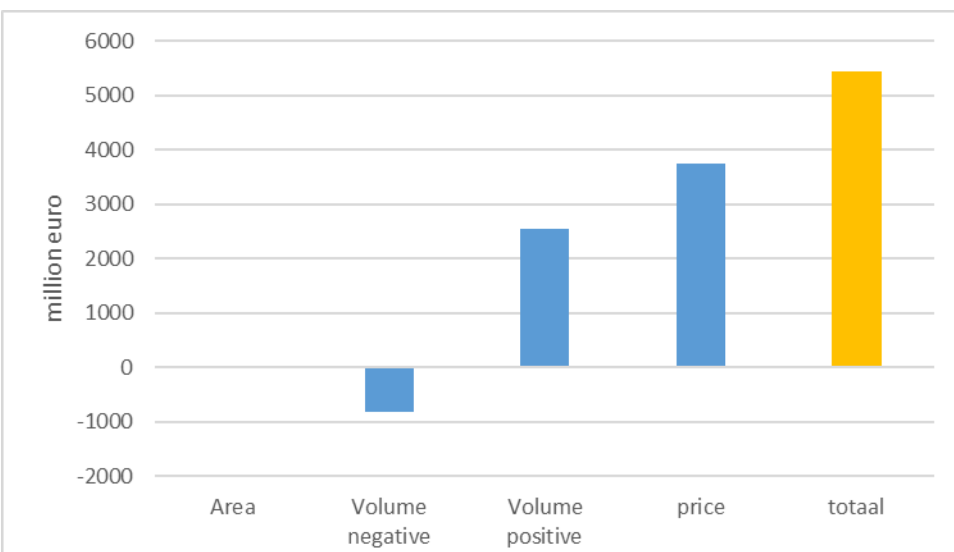

Figure 3.1 Decomposition results for the change in total supply of ecosystem services for the Netherlands (2013-2021)

Ecosystem services

Decomposition analyses for the different ecosystem services show quite diverse results. For nature recreation and amenity service for example, the total increase in value is due to price effects and a positive volume effect. For nature tourism we find a large price effect and a large negative volume effect. For carbon retention, the price effect is most significant. Overall the area effects are very small.

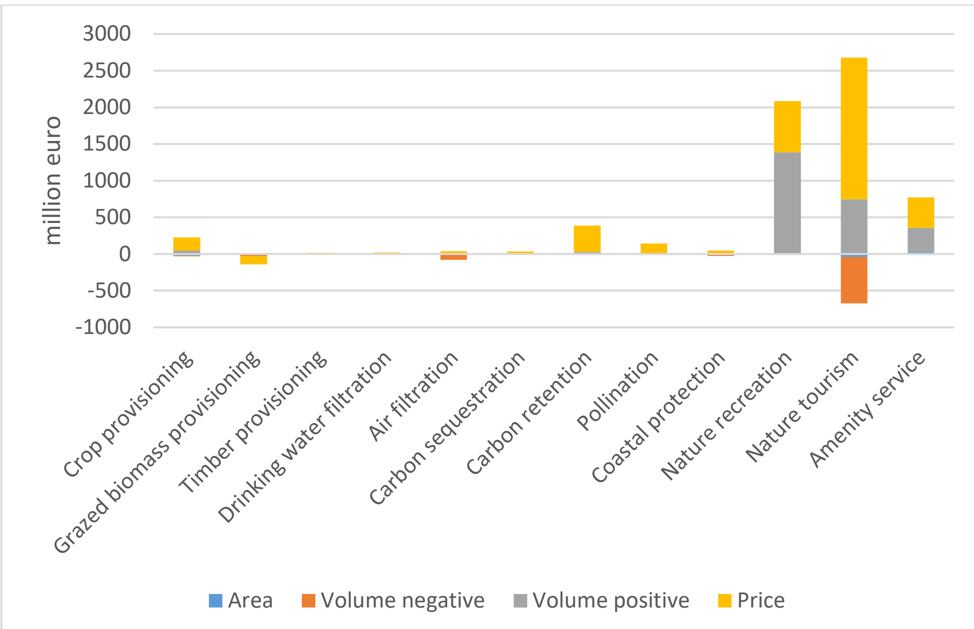

Figure 3.2 Decomposition results for ecosystem services values (2013-2021)

Ecosystem types

For all ecosystem types the total monetary value of supplied ecosystem services has increased for this period. To a large extent this is due to price increases for the ecosystem services. In addition, for some ecosystem types, such as forests, cropland, and grassland, we see a significant contribution of the volume effect with regard to the overall value change. For other ecosystem types, such as dunes and coastal area and lakes and reservoirs the negative volume effects are more significant than the positive volume effects. Area effects are in comparison small, but still significant for some ecosystem types such as cropland, grassland and urban green.

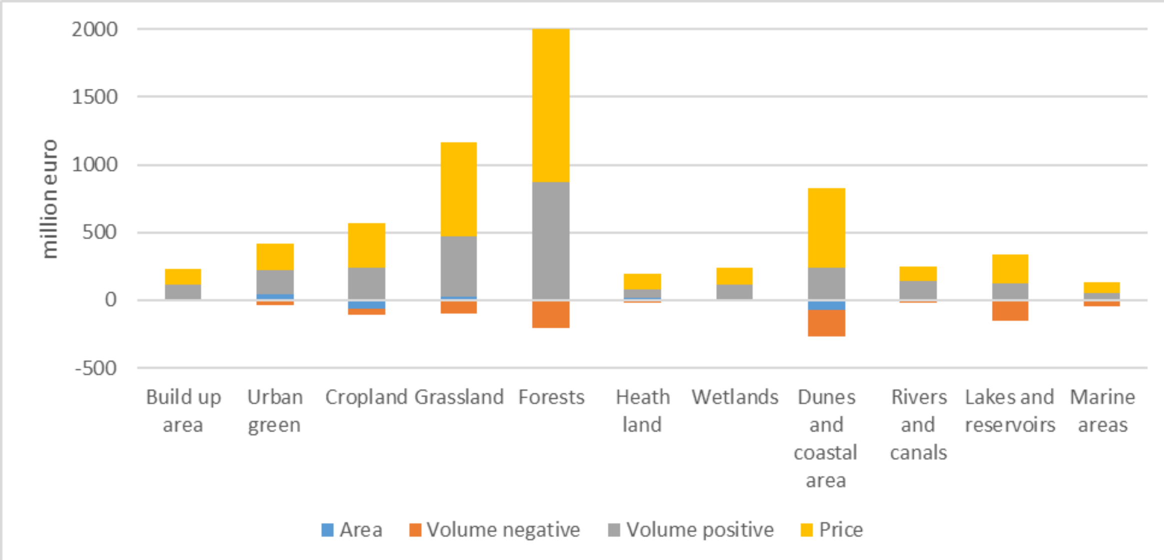

Figure 3.3 Decomposition results for ecosystem types (2013-2021)

3.4 Interpretation of the decomposition analysis

In this section we discuss how the results of the decomposition analysis can be used for the dissemination of monetary ecosystem values by looking more specifically at how to interpret the different effects.

Area effect

Overall, the area effect usually plays a minor role in explaining the overall value changes, given that the annual changes in extent are usually small. However, a more detailed examination of area effects provides useful information and insights. The effects of extent changes are in general easy to interpret and explain. Essentially, this effect illustrates **the impact of land use changes** on the value of the supplied ecosystem services. A positive/ negative area effect indicates respectively an increase or decrease of social economic benefits supplied by ecosystems as a result of land use changes. When looking at specific ecosystem types, this effect can be directly associated with changes in extent (Figure 3.4). For example, the extent of cropland in the Netherlands decreased between 2013 and 2021 with 461 km2, which resulted in a decrease in value of supplied ecosystem services (63 million euro). Likewise the extent of public green public space increased with 41 km2, which led to an increase in the value of supplied ecosystem services (43 million euro). For specific ecosystem accounting areas, for example provinces, the area effect reflects the overall land use changes that have occurred and their impact on the value of ecosystem services that are supplied. For the total of the country, positive and negative area effects will to a large extent balance out, and the overall effect will thus be small.

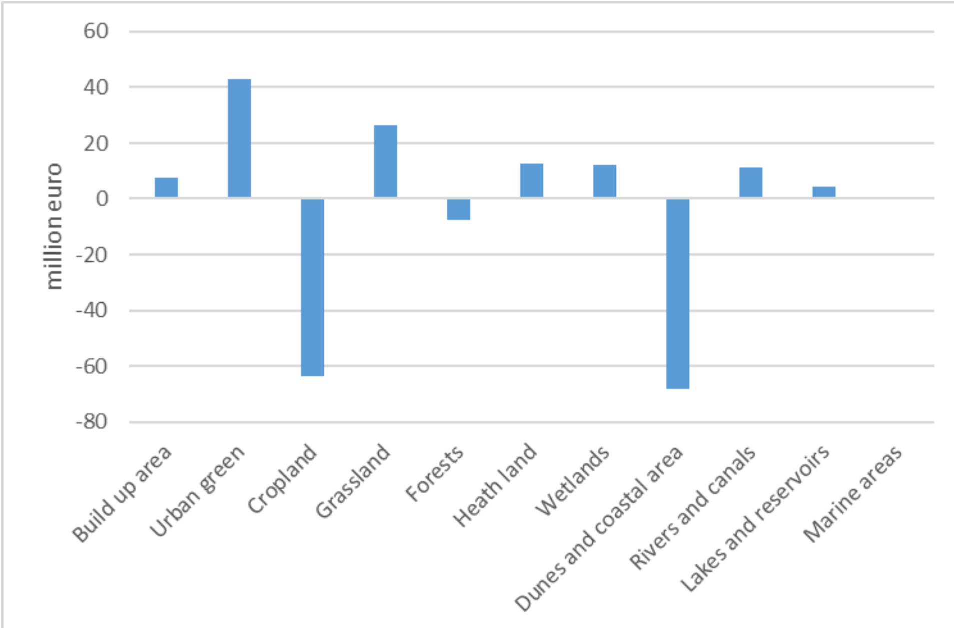

Figure 3.4 Impact of extent changes (area effect) on ecosystem service values (2013-2021)

Price effect

The effect of price changes is also in principle straightforward to interpret. Prices for ecosystem services (i.e. the monetary value per physical unit of the ecosystem service) are based on observed or imputed prices. A change in these prices reflects primarily a change in scarcity of the ecosystem service and the underlying ecosystem assets that supply them. For example, an increase in the carbon prices or nature recreation prices reflect a higher demand with respect to the supply of these services. In that regard it is interesting to compare the different price effects, for example for different ecosystem types.

Figure 3.5 shows the price effect as price indices, i.e. the average change in ecosystem service prices for an specific ecosystem type, during a given interval of time. For the total of the Netherlands, ecosystem service prices increased with 31.5 %. The increase in prices was higher than average for forests, marine areas, dunes and coastal areas and below average for rivers and canals and urban green. This then would be interpreted as a relative increased scarcity (more demand relative to supply) of the ecosystems services supplied by forests, marine areas, dunes and coastal areas relative to rivers and canals and urban green. These price indices can also be compared to other price indices like the consumer price index, which for this period was 12 %.

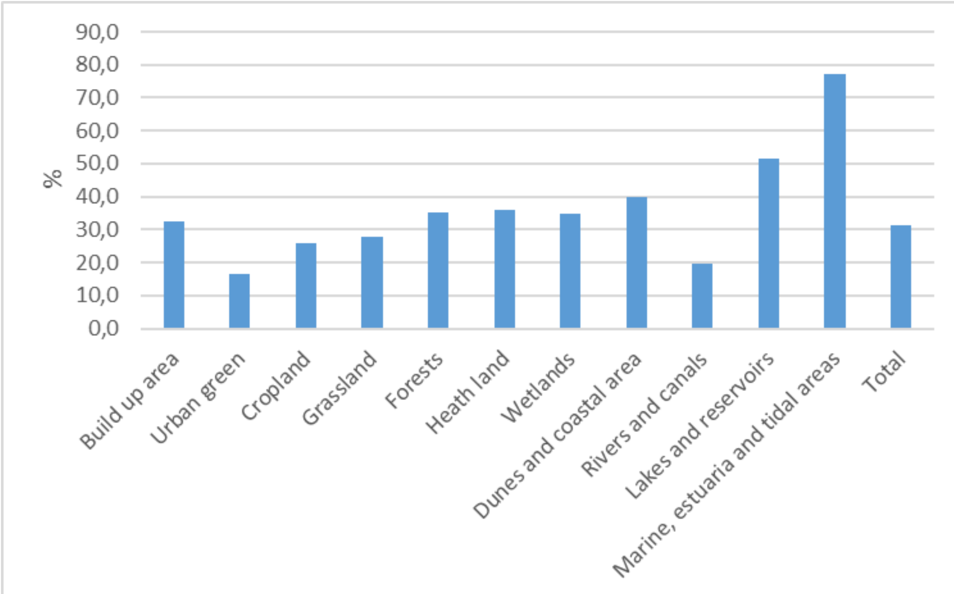

Figure 3.5 Impact of price changes (price effect) on ecosystem service values (2013-2021)

Volume effect

The effect of volume changes, i.e. changes in the physical supply per unit area (ha), is more difficult to interpret. Figure 3.6 shows the volume effect for different ecosystem types, both the positive and negative contributions to the change in value. Volume changes are in principle related to physical changes in supply or use:

- On the **supply side** ecosystems may provide more or less ecosystem services per hectare due to **changes in ecosystem condition**. For example, an improvement in the condition of forests may increase carbon sequestration and retention. Likewise, a deterioration of ecosystem condition (degradation) may result in a lower supply of ecosystem services, for example soil degradation may lead to less crop provisioning services.
- On the **use side**, changes in demand can have an important impact on the volume of ecosystem service provided and used. For example, population growth may increase the demand for cultural services like nature recreation and the amenity services. Likewise, less demand will lower the use of certain ecosystem services, like nature recreation or local climate regulation.

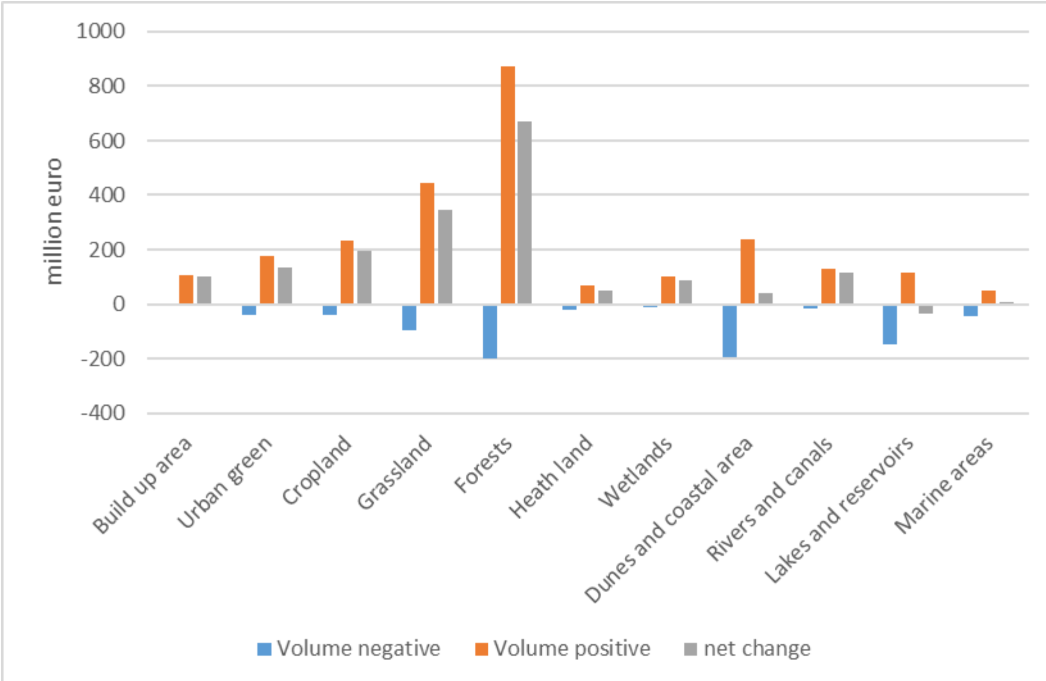

Figure 3.6 Impact of volume changes (volume effect) on ecosystem service values (2013-2021)

It is difficult to determine and distinguish the driving forces for volume changes, because changes in condition and demand may occur simultaneously. In SEEA EA, it is recommended to look at the condition account in order determine whether a change in volume can be related to a condition or demand change. However, this can be problematic to put into practice for several reasons. First, the focus for the condition account is usually on the so called intrinsic values. These often do not have a direct relationship with the amount of services supplied. Second, in practice the condition account requires a lot of data for compilation and the establishment of reference conditions. For the Netherlands, some data for the condition account is available, but this is insufficient to make a good assessment with regard to the impact on ecosystem services.

Here we propose a somewhat simplified approach to distinguish between condition and demand effects. As a first approximation we can apply the following:

> **In general, provisioning and cultural services are mainly driven by changes in demand**
> **In general regulating and maintenance service are mainly driven by changes in condition**

The reasoning for this is as follows. Cultural services are always supplied to households. In general, increases in these ecosystem services in physical terms, such as more recreational activities in nature areas and increased building of houses in the neighborhood of green areas, are mainly governed by more demand. Population growth, higher disposable income, and behavior changes can all drive an increased demand for these cultural services. Of course, condition changes may also influence the supply (i.e. less recreation when an nature area becomes much degrade), however it is safe to assume that for the time frame considered here and in this situation (i.e. the Netherlands) demand is the key driver for the volume changes of these services. Provisioning services can be governed both by condition and demand. For fish and timber provisioning services an increase in volume is likely to be related to increased harvest and thus demand. Crop provisioning services condition (soil fertility etc.) indeed play an important role, however for now we also assume here that demand is the dominant factor, as the calculation of the physical service in the Netherlands is based on harvest (but this point needs further consideration in the future). For regulating services we often observe that demand is greater than supply, which means that actual supply and use is determined by how much the ecosystems can provide. For example, there is more demand for carbon sequestration, pollination or local climate regulation than nature can provide. Accordingly, condition is most often the determining factor for the physical value of regulating ecosystem services.

When we apply this, we obtain the results as shown in Figure 3.7. We see that changes in condition are negative to the total value change, indicating that overall degradation of ecosystems causes a negative effect on the volume of ecosystem services supplied. Changes in demand are overall positive, with the exception for lakes and reservoirs, reflecting among others the effects of population growth but also an increased appreciation for what nature can provide to people.

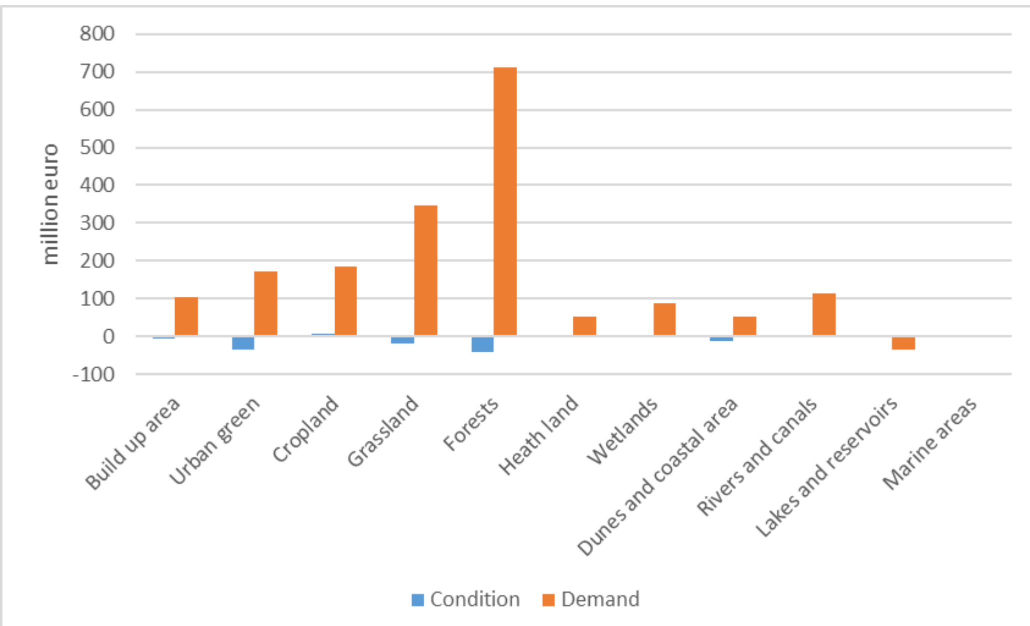

Figure 3.7 Volume effect decomposed into an condition and demand effect for different ecosystem types

We acknowledge that this approach is inherently an approximation. The supply of provisioning services may also be affected by changes in ecosystem condition, and the supply of regulating services may be affected by demand. The observed negative condition effects may vet be an underestimation, as the negative effect on ecosystem degradation on recreation and tourism is hidden by the overall increase we observe for these services. It may also be different from country to country. More detailed analysis may further refine this allocation to condition and demand, for example by looking in more detail how specific services work. However, the approach described above may work quite well as a first estimate.

4. Use and interpretation of monetary ecosystem values

Monetary values for ecosystem services and ecosystem assets provide interesting information and can express important messages for policy makers and other users of this data. The key question is how these values and changes over time should be interpreted.

In this section we will focus on how compilers of these statistical data can best present and interpret them for users. First, we will discuss the general interpretation of monetary ecosystem values, and then look at more specific statistical uses of these data.

4.1 General interpretation of monetary ecosystem values

It is important to recognize that there are multiple possible perspectives on the value of ecosystems. The purpose of value frameworks is to place the various perspectives in a common context. Two continuums are commonly used to reflect value perspectives: (i) the continuum from anthropocentric to non-anthropocentric values; and (ii) the continuum from instrumental to intrinsic and relational values (SEEA EA; par. 2.53):

- **Anthropocentric values** are those that are centered on human beings;
- **Non-anthropocentric values** are those that are centered on the environment;
- **Instrumental value** is the value attributed to something as a means to achieve a particular end;
- **Intrinsic value** refers to inherent value, that is the value that something has independent of any human experience or evaluation. Such a value is viewed as an inherent property of the entity (e.g., an organism) and not ascribed or generated by external valuing agents (such as human beings);
- **Relational values** are values relative to the meaningfulness of relationships, including the relationships between individuals or societies and other animals and aspects of the life world, as well as those among individuals articulated by formal and informal institutions.

These different value perspectives are not in some manner additive, i.e. it should not be concluded that, by recognizing all types of value, an aggregate value of nature could be obtained. Rather, it is more appropriate to consider that, for a given ecosystem, each value perspective will provide a different value – i.e., there are multiple, potentially incommensurate, values to be compared and contrasted in decision making. Importantly, all values and associated frameworks recognize that the environment has value beyond that reflected in monetary values.

The focus of the SEEA EA is on values of **anthropocentric origin** – i.e., values that are centered on human beings (SEEA EA; par 2.54). Furthermore, the measurement focus is commonly on **instrumental or use values**, in part because these interactions are most readily quantified and also because, from a monetary valuation perspective, these values are most readily reflected in monetary terms. This perspective also follows from the '**societal benefit perspective'**, one of the five measurement perspectives that lie at the basis of the SEEA EA, where ecosystems are seen as a source of benefits for people, the economy and society potentially in terms of a relational connection or in a more economic sense of supplying services and benefits (SEEA EA; par 2.7). From a policy perspective, the focus on anthropocentric, instrumental values is of high relevance since they concern the types of human interactions with the environment that can place the most pressure on ecosystems

The framing of values and the perspective applied in SEEA EA is essential for understanding and interpreting monetary values that can be derived from monetary ecosystem accounts. The second critical element for the interpretation is that the monetary values provided by SEEA EA are based on exchange values (see chapter 2).

Summarizing, monetary values for ecosystem services and ecosystem assets calculated according to the SEEA EA guidelines represent **social economic use values**. This means that these values indicate the direct benefits that we as a society derive from ecosystems, or, in other words, how much nature contributes to our wellbeing and economic development. High/ higher monetary values represent a high(er) contribution by ecosystems, and low(er) monetary values a low(er) contribution by ecosystems. Likewise, these values express our **dependency on ecosystems** to provide services that are essential for our wellbeing and economic development. Higher or lower values thus indicate whether we are becoming more or less dependent on nature. As a result of this framing, it also follows that values should always be presented in the right context by providing a kind of comparison between different numbers, i.e. standalone values as such are meaningless.

It is also good **to make clear what the SEEA EA monetary ecosystem values do not express**. First, by definition these monetary values do not incorporate intrinsic values. An intrinsic value is "a value that resides in the assets, especially in the environmental assets, but that is independent from human preferences" (Pearce and Moran, 1994). The concept of intrinsic value means that an object, in this case nature, is valuable *for its own sake* as opposed to being valuable *for the sake of something else* to which it is related in some way. Intrinsic values may be captured in physical terms (for example data on biodiversity), but by definition not in monetary terms. Second, SEEA EA focusses on exchange values and thus excludes welfare values, i.e. values that include consumer surplus and non-use values (see also chapter 2). The monetary SEEA EA values thus express what nature actually contributes to our wellbeing, not what people are willing to pay (more) for certain ecosystem services. Third, monetary ecosystem values as such are not indicators for ecosystem condition. High or low monetary values say nothing about the quality of ecosystems. For ecosystem accountants this may seem obvious, but this may not be apparent for the users of the data. Finally, monetary ecosystem values may help to describe and evaluate certain aspects of sustainability, however in general care must be taken to use and interpret them as sustainability indicators as such. Sustainability indicators show how sustainable something, including (economic) processes, products, services and businesses. The principal objective of sustainability indicators is to inform public policy-making as part of the process of sustainability governance. A change of the indicator should therefor express if a certain process of activity becomes more or less sustainable with regard to our environment and society. Ecosystem services in SEEA describe actual supply and use and not the sustainable supply and use. For example, overfishing and overharvesting of timber result in higher values for these services, which express that nature is more used (or exploited) for economic purposes, but obviously this is not good for the environment. Monetary ecosystem values thus are not easily interpreted with regard to sustainability.

Summarizing, monetary values express to what extent society is using and benefiting from our natural environment, and how dependent we are on nature, but these values say nothing with respect to the condition of ecosystems or whether the current use of nature is sustainable.

4.2 Specific statistical applications and interpretation of monetary values

Several potential uses and applications for exchange value based monetary valuation of ecosystem services and assets have been identified (for an overview see SEEA EA par. 8.3). Here we will provide an overview of the more general statistical uses of this data, i.e. the different options how these data can be best presented and disseminated by statistical offices. Table 4.1 provides an overview of the different options we have identified. This is not a comprehensive list, but in principle contains the main applications.

Table 4.1 Overview of different options for presenting monetary ecosystem values

Intercomparibility of monetary ecosystem values
Ecosystem services
Ecosystem types (total ecosystem serivces supply by)
Ecosystem areas (total ecosystem serivces supply by)
Users of ecosystem services
Ecosystem assets
Comparison with macro-economic variables
With macro-economic flow indicators (value added, GDP etc.)
With environmental expenditures
With non-financial assets
With land prices
Change in time
Ecosystem services
Ecosystem types
GEP
Ecosystem assets (total value ecosystem capital)
Comparison with physical ecosystem account data
Extent
Condition

Here we will discuss in detail most of these options, which will be illustrated by analyzing data for the Netherlands. In addition, an interpretation and explanation will be provided putting the values in their right context.

4.3 Intercomparability of monetary ecosystem values

Valuing ecosystem services and assets in monetary terms means that they are expressed in one common unit, namely (in the case of the Netherlands) euro's. This has the great advantage that different values can be aggregated and directly compared. The first application of monetary value is therefore the direct intercomparability of the monetary values of different ecosystem services, ecosystem types or different areas. Comparing these values should be done in the light of the general interpretation of the monetary ecosystem values as described in the previous section.

The first useful comparison is that of the values for the different ecosystem services. **Basically. this comparison will indicate which ecosystems services provide the most benefits.** Figure 4.1 shows the ecosystem services that have been valued for the Netherlands. Cultural services have significantly higher monetary values compared to provisioning and regulating services. This general pattern has also been observed for other countries, such as the UK (ONS, 2023). Values for regulating values are low compared to both cultural and provisioning services, with the exception of carbon retention.

Interpretation: For the Netherlands**,** nature recreation and nature tourism provide the highest social economic use values, followed by the amenity service and carbon retention. These ecosystem services thus provide more social economic benefits than provisioning services (e.g. crop production, timber production) and (most) regulating services (e.g. water purification, coastal protection).

Explanation: The Netherlands is a densely populated country. There is a high demand for recreation/tourism in nature areas and living near green areas. The related expenditures are an important contribution to our economy, but these cultural services also provide all kinds of social benefits including health benefits. The Netherlands has a substantial agricultural activities that take place on cropland and grassland. The ecosystems provide an important contribution (soil fertility, soil water, soil structure, pollination etc.) to these activities. However, the related exchange values are lower compared to cultural services. The lower exchange values of regulating services have several causes. Some regulating services have not yet been included or valued for the Netherlands (e.g. local climate change, water regulation etc.). Also, valuation methods chosen for regulating services are primarily based on revealed preference methods. Here in principle the method should be chosen that provides the lowest estimate. For example, for the Netherlands we have applied the replacement cost method to value the coastal protection service. Alternatively, an avoided damage costs approach could have been applied, which would have resulted in different (probably higher) values.

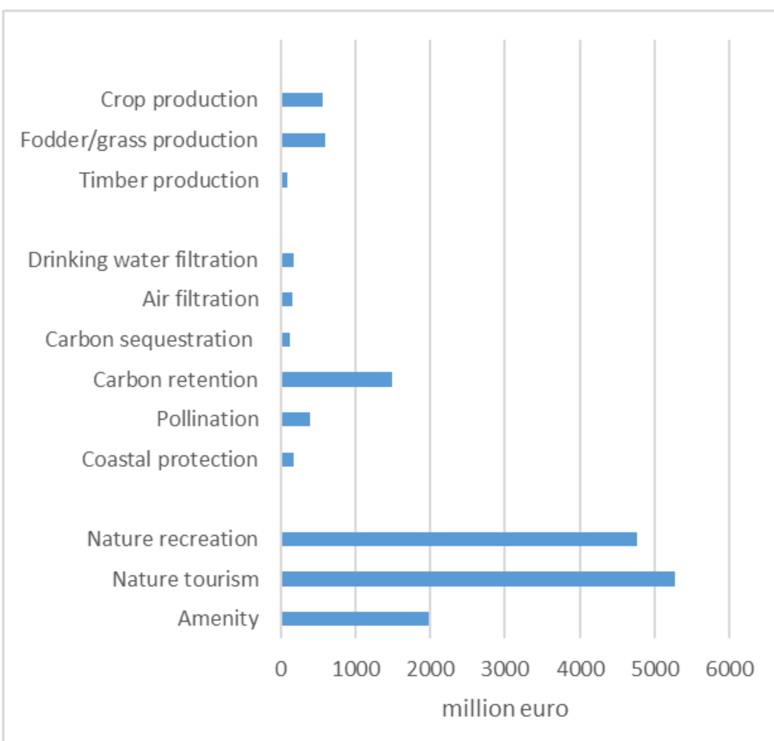

Figure 4.1 Monetary values for different ecosystem services (2021)

Second, values of the supply of ecosystem services by different ecosystem types can be compared. Basically, this comparison indicates which ecosystem types provide most benefits to society. Figure 4.2 shows the total value of ecosystem services provided by the main ecosystem types in the Netherlands. Forests provide the highest values, followed by grassland and dunes and coastal area. Build-up areas and heath land provide the lowest values. Maybe more interesting are the differences in values per ha, which have been plotted in the same figure. Here we see relatively high values per ha for all (semi) natural ecosystem types (with the highest value for dunes and coastal areas) and urban green areas. Agricultural ecosystem types and build-up areas have lower values per hectare.

Interpretation: For the Netherlands, **f**orests supply most social economic benefits, followed by grassland and dunes and coastal area. Cropland supply also significant social economic benefits, but their contribution per hectare is much lower compared to (semi)-natural ecosystem types.

Explanation. Forests provide a relatively high contribution to many different ecosystem services that are high in demand, in particular nature recreation, nature tourism and carbon retention. In addition, the extent of forests (as an ecosystem type) is larger than the other (semi)-natural ecosystem types. Dunes and coastal areas contribute much to nature recreation and tourism and coastal protection resulting in a high value per hectare. As their extent is small, the total value is lower than forests. Agricultural ecosystem types have a relatively large extent, they provide provisioning services but much less cultural services, resulting in a significant total value, but low values per hectare. Urban green areas, on the other hand, are located in or near populated areas and provide many recreation and amenity services, resulting in high values per hectare.

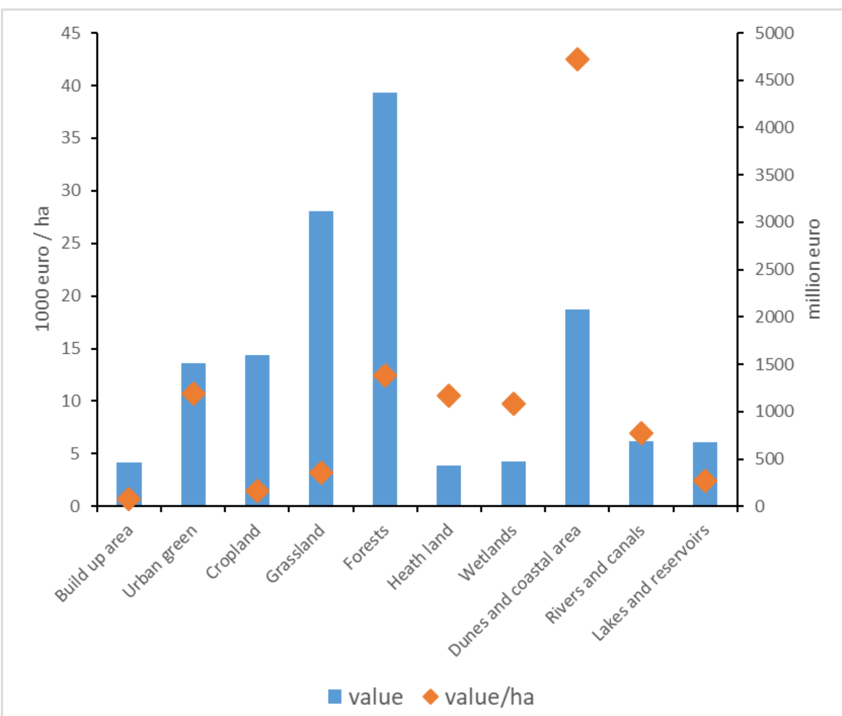

Figure 4.2 values of the total supply of ecosystem services by different ecosystem types (2021)

Third, values for different areas (ecosystem accounting areas) can be compared. Accordingly, areas can be identified that provide particular high (or low) benefits. As an example, we present and compare here the total values of ecosystem services supplied in the different provinces of the Netherlands (Figure 4.3). Values are highest for the provinces Noord-Holland, Zuid-Holland, Gelderland and Noord Brabant, and lowest for the provinces Flevoland, Groningen and Utrecht. Again, more interesting here are the values per ha. Here, we see for some provinces a different picture, namely for Utrecht and Limburg we see low or medium total values, but relatively high values per hectare.

Interpretation: Supply of ecosystem services is the highest in the provinces Noord Holland, Zuid Holland, Gelderland and Noord Brabant. In these provinces nature contributes (relatively) more to our wellbeing and economic development. Conversely, in Flevoland, Groningen and Utrecht the contribution by nature is less.

Explanation: Noord Holland, Zuid Holland, Gelderland and Noord Brabant are relatively large provinces (extent), and also have high population numbers compared to the other provinces. Accordingly, there is a higher demand for ecosystem services, in particular for nature recreation and amenity services. In addition Noord and Zuid Holland are coastal provinces with dunes an beaches that provide, besides coastal protection, a lot of beach recreation, tourism, also for visitors from other provinces and from abroad. Gelderland and Noord Brabant have relatively a large share of forests, offering not only cultural services, but also carbon sequestration and carbon retention. The smaller provinces like Utrecht and Limburg have relatively more (semi)-natural areas that supply ecosystem services, and values per hectare here are higher. Provinces like Groningen and Flevoland are predominantly agricultural with less (semi)-natural areas, and have a lower population density.

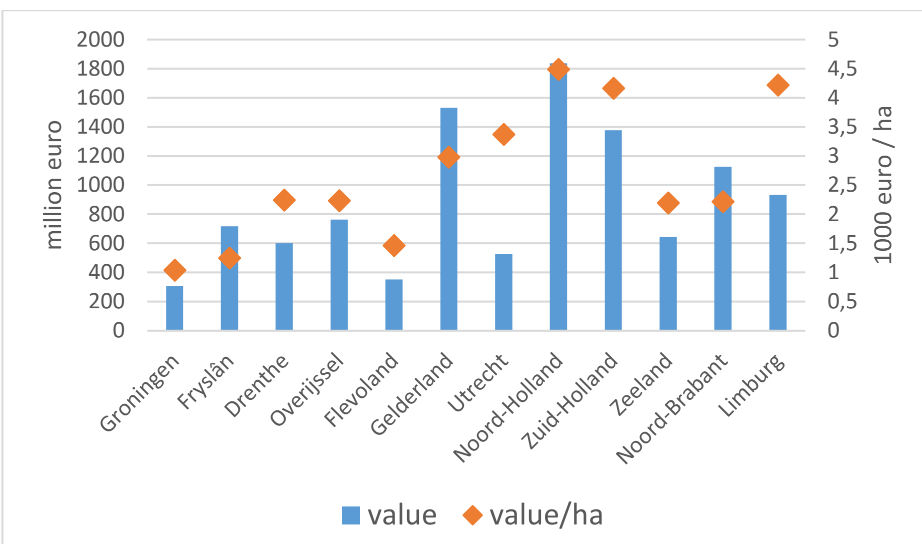

Figure 4.3 Values for the supply of ecosystem services for the different provinces of the Netherlands (2021)

Fourth, the direct users of ecosystem services can be compared. **This will reveal who are the principle beneficiaries of nature, but also who is most dependent on nature.** Figure 4.4 shows four groups of beneficiaries: companies (mainly agriculture), households, government (using services collectively consumed on behalf of society) and non-residents (export of ecosystem services). Values are highest for households followed by government and companies.

Interpretation: For the Netherlands, households by far are the main beneficiaries of ecosystem services. Indirectly they also benefit from certain ecosystem services like for global climate regulation where the government acts as the collective user. They thus profit most from a healthy natural environment as a provider of ecosystem services. Likewise, they are also most dependent on ecosystem services and would be affected most when the provision of services would diminish.

Explanation: Households and non-residents are (by definition) the users of cultural ecosystem services, which provide, as discussed above, most social economic use values. Some regulating services are for the benefit for the whole society, and therefore also the government is an important user of ecosystem services. Companies are less important users of ecosystem services. Here it is important to note that although the direct use is low, and specific for some industries (agriculture, forestry, fisheries, water companies), companies often indirectly benefit from (or are dependent) on a) ecosystem services provided to households (for example by the expenditure for recreation and tourism), b) ecosystems supplied in the rest of the world (needed for the production of products that are imported to the Netherlands), and c) in general can only function properly in a stable natural environment.

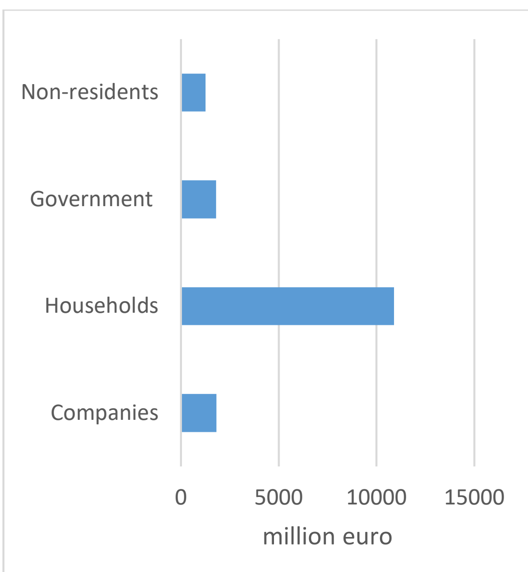

Figure 4.4 Use of ecosystem services in the Netherlands (2021)

Fifth, **ecosystem capital values** (asset values) can be compared, for example for different areas. Figure 4.5 shows the map of the Netherlands with the monetary value of ecosystem capital (in 1,000 euros per hectare). High values per hectare can be found throughout the coastal region (dunes and beaches). Furthermore, also large nature reserves such as the Veluwe, the Utrechtse Heuvelrug, but also smaller areas in Drenthe, Overijsel, Noord Brabant and Limburg are characterized by relatively high values that exceed 400 thousand euros per hectare. Large cities such as Amsterdam, Rotterdam and The Hague have low values, but the more open and green areas immediately surrounding the cities have a high value.

Interpretation and explanation: Maps for ecosystem capital allow the identification of 'ecosystem hotspots' that represent areas of significant natural wealth. Nature areas in particular have high monetary values when we take into account the ecosystem services they provide to society, now and in the future. The high values for green areas near large cities make it clear that these areas fulfill an important function, especially for recreation from the city. Large bodies of water such as the IJsselmeer, the Wadden Sea and the Oosterschelde and Westerschelde now have a relatively low value on the map, mainly because specific ecosystem services provided by these areas are still outside the scope of the Dutch accounts.

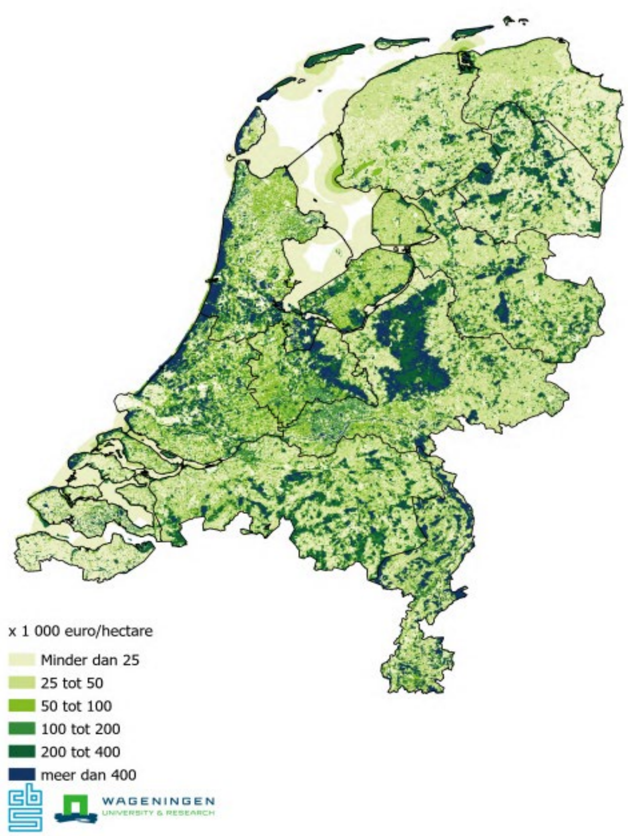

Figure 4.5 Value of ecosystem capital (TAV) for the Netherlands, 2020

4.4 Comparing monetary ecosystem values with macro-economic data

The second application is the comparison of the monetary ecosystem values with macro-economic variables from the System of National Accounts (SNA). As the monetary SEEA EA data are based on exchange values, this in principle is a valid comparison. There are many possible comparisons, the question however is which comparisons are meaningful, and how should these be interpreted ? Here we present and discuss various options, starting with monetary flows, i.e. the values of ecosystem services, followed by values for ecosystem assets.

Ecosystem services are contributions by ecosystems to SNA and non-SNA benefits. A first valid comparison is therefore to compare the value of the ecosystem services with the respective values for the economic activities to which they contribute. These are production activities (where companies are the users), consumption activities (where households and government are the users) and exports (non-residents as users). In figure 4.6 the value of ecosystem services is expressed as a percentage of total value added, consumption or exports respectively. For the whole of the economy, the total supply of ecosystem services (or gross ecosystem product, GEP) is divided by GDP. Results for the Netherlands show that for companies that are direct users of ecosystem services the contribution of ecosystem services varies between 10 and 20 %, with the exception of forestry where it is 50 %. The contribution of ecosystem services in monetary terms is much lower (3 % or lower) when compared with household or government expenditure, exports or GDP.

<u>Interpretation, explanation and clarification:</u>

Ratio indicators, like the share of GEP in GDP, have received a lot interest, but are also controversial. In principle, these ratio's indicate the contribution of ecosystems to economic activities, and thus the dependency on nature for our economic wellbeing. The issue however is that the interpretation of these indicators is not straightforward. Generally, these ratio indicators based on exchange values are often considered 'low', which may lead to the interpretation and conclusion that the contribution of nature is 'not very significant' or 'less important'. As is shown in figure 4.6 this is also the case for the Netherlands. To adequately understand what these ratio's mean and how to use them as indicators, we can make the following four observations, taking the data from the Netherlands as an example.

First, not all ecosystem services relevant to the Netherlands have yet been valued monetarily. For example, water regulation services, local climate regulation, and also some services that are specific for the marine environment have not yet been taken into account. In addition, certain value aspects have not yet been included, for example beneficial health effects as a result of recreating and spending time in nature areas. The calculated share of the contribution of ecosystem services to economic benefits is therefore by definition an underestimation. However, while expanding the scope of services may increase the value of ratio indicators, dramatic increases in values are not expected as most of the key ecosystem services have already been included.

A second observation is that, to some degree, these low ratio's correspond to an economic reality. A large part of the Dutch economy is not or little directly dependent on the contribution of Dutch, i.e. national ecosystems. The primary sector (agriculture, forestry, fisheries) is the most important direct user of ecosystem services. However, Dutch agriculture is capital intensive, meaning that important parts of the agricultural sector, such as greenhouse horticulture and intensive livestock farming, are relatively less dependent on natural capital. Forestry and fishing are relatively less important sectors from an economic point of view, and likewise capital intensive. Accordingly, an ecosystem contribution between 10 and 20 percent is something that is quite reasonable. Other industries are not directly dependent on ecosystems. They may indirectly depend on ecosystems, for example because their production process relies on inputs that do directly depend on ecosystems (for example food products or recreation services), or because more in general they need a healthy and safe environment for their employees to work and live in. Households benefit more from ecosystem services, but obviously households need and consume many other products and services, so the share of ecosystems services will be small in comparison. Finally, exchange values for regulating services which are often for the benefit for our whole society are relatively low. As discussed above, their values are often based on the least costly alternative for which a market value us available. Thus, based on these reflections it is not surprising that ratio indicators like GEP / GDP based on exchange values are relatively low.

A third observation is that, even though values for ecosystem services and ecosystem assets and macro-economic variables from the SNA are based on the same valuation principles (i.e. exchange values), this does not mean that these comparisons can be used to 'trade off or trivialize nature' (DEFRA, 2023). These ratio indicators thus cannot be used to conclude that nature's contributions are relatively 'unimportant' or 'not significant'. Particularly with regard to comparisons with the total consumption or GDP, the question is if these are meaningful comparisons. We can illustrate this with several examples. For agriculture, the contribution of land/ecosystems is 12 %, which is less than the contribution of labour (29 %; employees only) or produced assets (38 %). However, it is clear that without a healthy soil agriculture would not be possible. Ecosystem services provide an essential input, even if the value is lower than the labour or capital input. Households need a healthy environment for living and recreation. Even if the actual household expenditure for this is only 3%, it is recognized that these ecosystem services are crucial for our well-being. Regulating services play an essential role in maintaining and regulating our environment which are critical for our well-being, even if there exchange values are relatively low. Here, exchange values simply do not express (or underestimate) the overall benefits that are delivered to society.

A fourth and last observation that we can make (and related to the previous point) is that whether a figure of 15.8 billion euro for GEP or a ratio of 1.8 % for GEP/GDP is low, is clearly a matter of perception. 15.8 billion euro may be 'small' compared to GDP, but compared to other monetary data it is a huge amount of money.

Concluding, even though ratio indicators that combine monetary ecosystem values with macro-economic variables, in principle are valid comparisons (i.e. values are all based on exchange values), they are often easily misinterpreted. If calculated and disseminated great care must be taken to provide them in the right context. However, because of the risk of misinterpretation but also because often the comparison is not very meaningful, we advocate not to focus on these ratio indicators when disseminating monetary ecosystem values. As will be discussed below, the overall trend in these ratios, however, may provide more meaningful information.

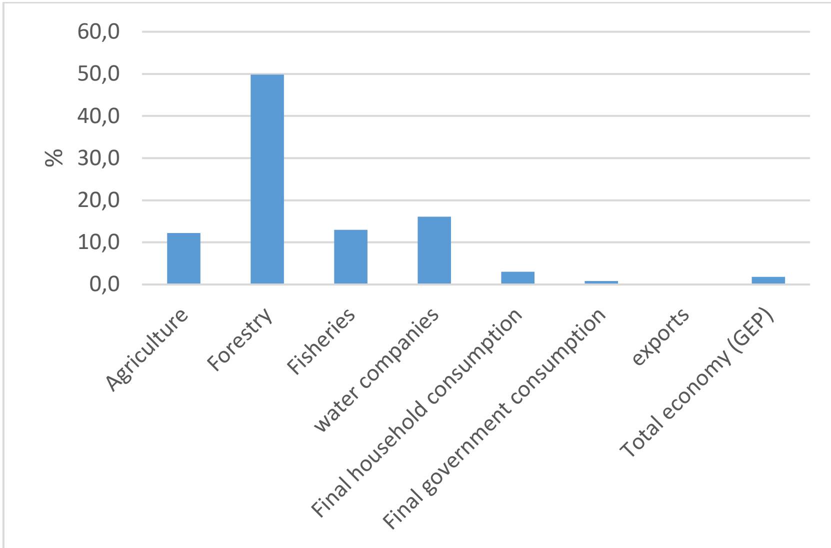

Figure 4.6 Contribution of ecosystem services to value added of various industries, consumption, exports and GDP (2021)

Ecosystems service values can also be compared with the total expenditures for nature and biodiversity management. These expenditures can be obtained from the environmental expenditures accounts (EPEA), CEPA 6. In a sense this is a kind of cost benefit analysis, as the value for ecosystem services expresses the benefits derived from nature, and the environmental expenditure the costs that society spends on managing and preserving nature. Figure 4.7 shows that for the Netherlands the value of ecosystem services provided by (semi)-natural ecosystems is approximately 6.1 times higher than the total related environmental expenditure (2021).

Interpretation: The social and economic benefits we derive from nature are much higher than the current costs for managing our natural environment. Ecosystem accounting makes visible the benefits that are usually not recognized when analyzing the expenditures for managing nature areas.

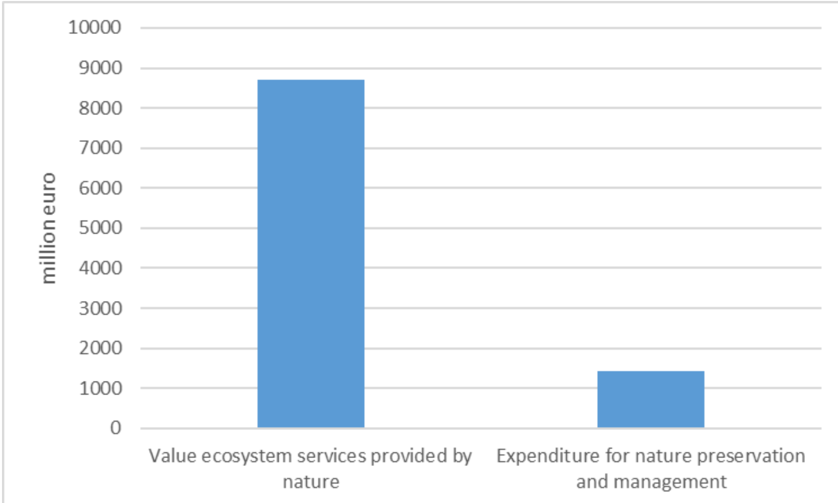

Figure 4.7 Comparison between the costs (environmental expenditure) and benefits (ecosystem services provided) for (semi) natural areas (2021)

Values for ecosystem assets (ecosystem capital) can be compared to other non-financial assets, like produced assets, land under buildings, oil and gas reserves etc. as recorded in the National Accounts. Care has to be taken to avoid double counting, for example crops that are also a produced asset, and the value of agricultural land (as obtained from land prices) that overlaps with values of agricultural ecosystem assets based on SEEA EA valuation. Figure 4.8 shows that for the Netherlands 15 % of the non-financial assets consist of ecosystem capital.

Interpretation: Ecosystem capital is a major source of national wealth. Nature compares favorably with conventional assets when measured on a national level. Ecosystem capital provides more economic benefits then civil engineering works or other fixed assets (i.e. all machinery, transport equipment and software), but less than dwellings or land under dwellings.

Here again it is important to acknowledge that the value of ecosystem capital is probably an underestimation. Although the 15 % share in total non-financial assets looks more substantial than the 2 % observed for GEP/GDP, in principle the same critical observations can be made here as in the previous section. Care thus has to be taken when comparing very different assets like dwellings and ecosystem capital.

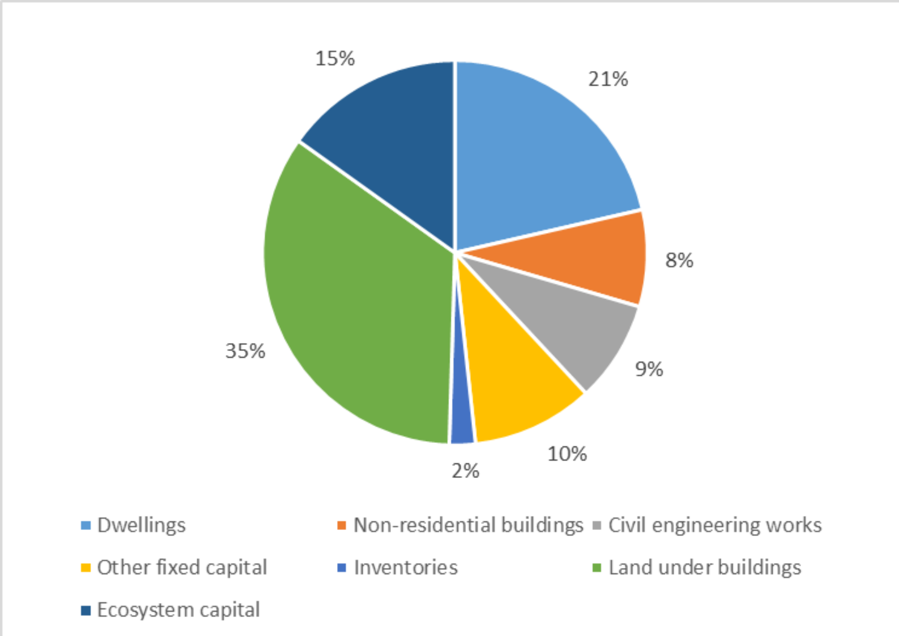

Figure 4.8 Non-financial assets including ecosystem capital (2021)

Another comparison is the per hectare (or m^2) comparison of ecosystem asset values with 'real' land prices. This is interesting because the benefits provided by ecosystems are often not accounted for in actual land prices. Figure 4.9 shows the per m^2 values based on data from the non-financial asset account (land beneath dwellings and non-residential buildings; agriculture) and monetary SEEA EA accounts (nature areas). Total monetary values have been divided by their extent (obtained from the extent account) to derive the per m^2 values. The average per m^2 value for semi-natural areas in the Netherlands is lower than land beneath dwellings and nonresidential buildings, but higher than agricultural land. These are average values, for some specific nature areas we observe that the per m^2 values approach the values for land beneath dwellings and nonresidential buildings. Figure 4.10 shows the per ha values for some specific ecosystem types based on the monetary SEEA EA accounts and actual observed market land prices. For agricultural ecosystem types the per m^2 values are comparable, but for semi natural ecosystem types there is a significant difference.

Interpretation: Actual land prices to a large extent do not incorporate the benefits that are obtained from ecosystems. Including these benefits results in significant higher land prices than the observed market prices. Current land prices for nature areas are thus undervalued.

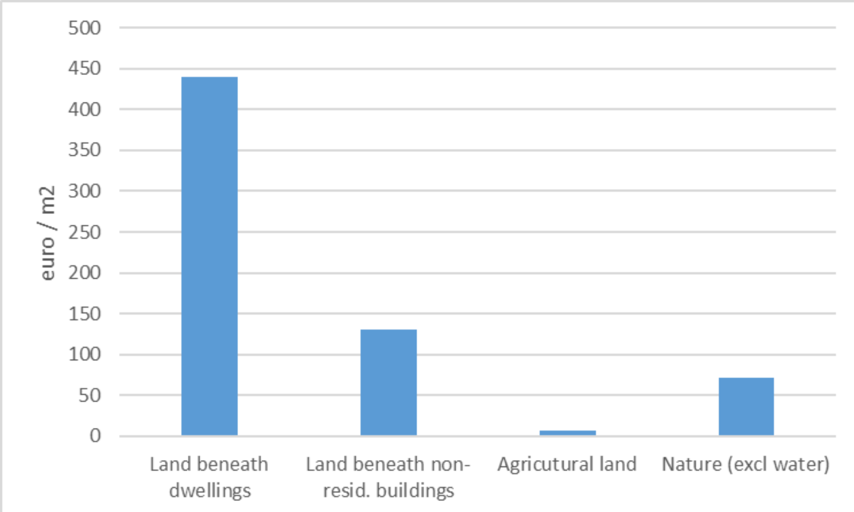

Figure 4.9 Comparison of land prices based on non-financial asset and ecosystem capital values (2021)

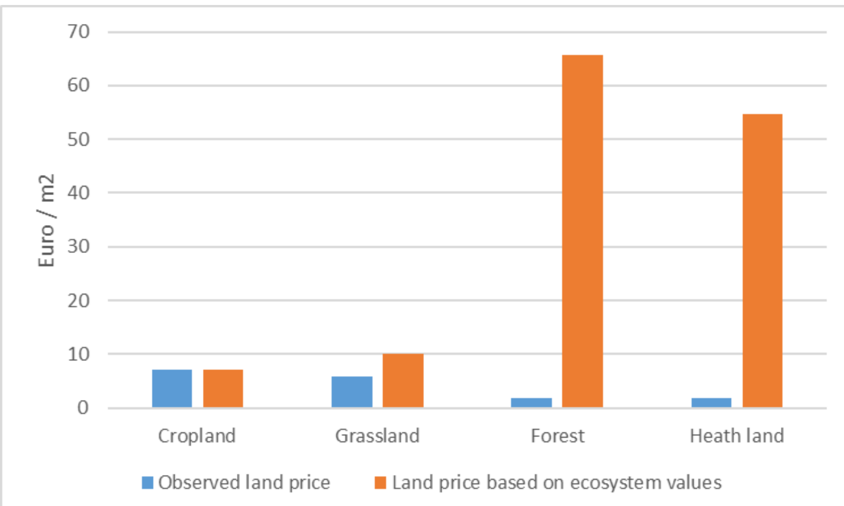

Figure 4.10 Comparison of actual land prices and land process based on ecosystem values (2021)

4.5 Changes over time (comparing monetary ecosystem values over different time periods)

A third important statistical application of monetary ecosystem values is evaluating their change over time. Following the general interpretation of monetary ecosystem values presented in section 4.1, **a change in value over time (both with regard to ecosystem services and assets) indicates that ecosystems contribute more or less to social economic benefits, or, in other words, add more or less value to human wellbeing.** However, this general interpretation may not always be straightforward to comprehend and (again) could be misinterpreted (i.e. that higher values over time would indicate that nature is doing better). For the correct understanding it is also important to know more about the drivers of these changes. Here, the results of the decomposition analysis may help to provide more clarity and insight. Below we will present and discuss some key examples of monetary value changes over time and how these could be best understood, namely an individual ecosystem service (nature recreation), an individual ecosystem type (forest), GEP, and GEP/ GDP.

Ecosystem services: example nature recreation

Recreation-related services are the ecosystem contributions, in particular through the biophysical characteristics and qualities of ecosystems, that enable people to use and enjoy the environment through direct, in-situ, physical and experiential interactions with the environment. In the Netherlands, we distinguish between nature recreation (day activities) and nature tourism (including an overnight stay). The value of the nature recreation service (i.e. only day activities) increased from 2678 million euro in 2013 to 4765 million euro in 2021 (Figure 4.11). Several different activities can be distinguished, namely hiking, cycling, outdoor sports, touring the countryside by car or motor etc. In particular, the value related to hiking more than doubled. Also the value related to cycling and outdoor sports and touring by car / motor in nature areas increased.

Interpretation: Over time, by providing options for recreation nature has been contributing more to social economic benefits, and in that sense is contributing more to our wellbeing. The increase in value over time is primarily caused by an increase in demand, i.e. people are undertaking more and more activities in nature for leisure. In particular, there was more demand for hiking in nature in 2021 as a result of the COVID measures where other leisure activities were more restricted. In addition, the value has also increased due to higher prices, i.e. higher average prices paid per activity. This is interpreted that people are willing to pay more for this ecosystem service.

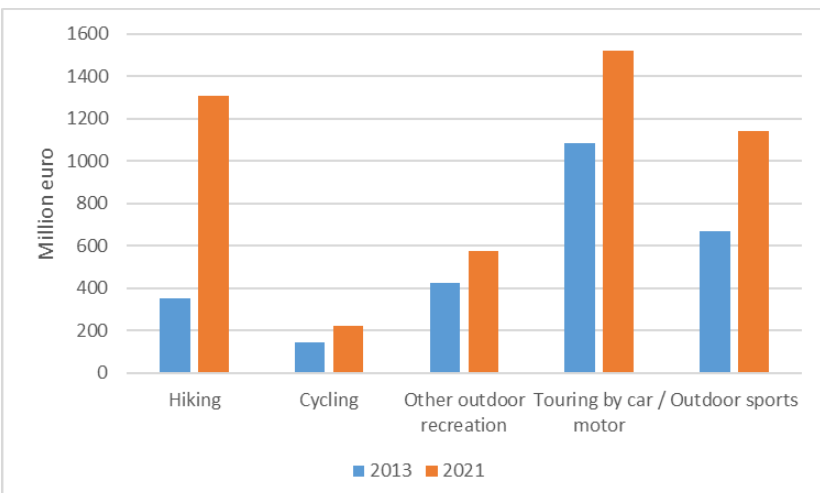

Figure 4.11 Value change 2013-2021 of different aspects of nature recreation

Ecosystem types: example forests

The value of ecosystem services supplied by forests has increased from 2737 million euro in 2013 to 4556 million euro in 2021, a total increase of 1819 million euro (Figure 4.12). Ecosystem services that contributed most to this increase are nature tourism (+647 million euro), nature recreation (+899 million euro), amenity (+183 million euro) and carbon retention (+64 million euro).

Interpretation: The benefits provided by forests to our society have increased with 66 % between 2013 and 2021. There are several causes (or drivers) for this increase. The increase in value is primarily related to an increase in price (1155 million euro), reflecting an increased scarcity. Also the increase in demand for ecosystem services provided by forest had a significant contribution (712 million euro). Ecosystem degradation had a negative impact on the value (-40 million euro). Finally, the reduction in forest extent caused a decrease of 8 million euro.

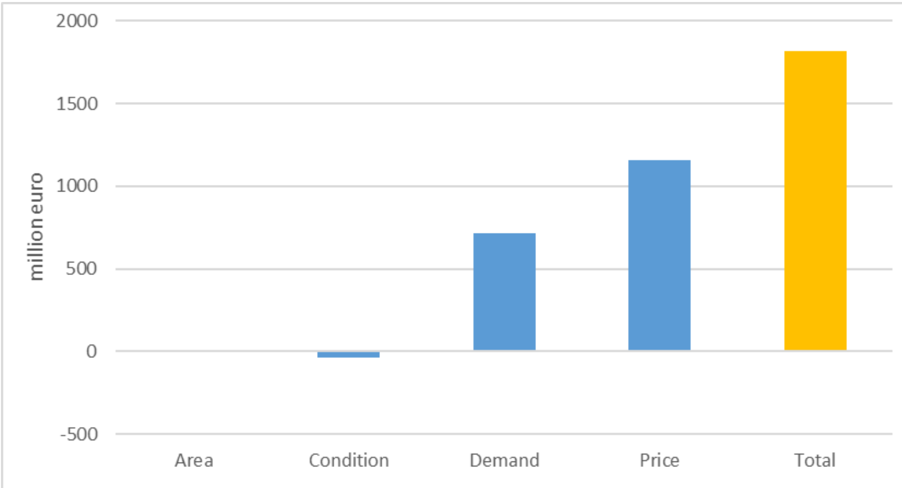

Figure 4.12 Drivers of the total value change of forests (2013-2021)

Gross ecosystem product (GEP)

For the Netherlands GEP has increased from 10.3 billion euro in 2013 to 15.8 billion euro in 2021 (Figure 4.13). Ecosystem services that contributed most to this increase are nature recreation (2086 million euro), amenity (757 million euro), nature tourism (2007 million euro) and carbon retention (373 million euro). 2020 saw a sharp decrease in GEP to 12.4 billion euro, primarily because nature tourism declined as a result of the COVID pandemic.

Interpretation: GEP is a measure for the total national contribution of nature to human well-being and the economy. GEP is also in effect a measure of the total 'ecological output' or 'GVA of nature'. A change in GEP over time thus indicates that this ecological output and its use in the economy and society has increased or decreased.

Nature's contribution to the Dutch economy and society has increased with 53 % between 2013 and 2021. In other words, ecosystems in the Netherlands have provided more benefits to its people. The increase in GEP in this period had several causes. First, an increase of the prices for the ecosystem services resulted in an increase of 31 % of GEP. This price effect reflects both an increased willingness to pay more for ecosystem services (for example more expenses for recreation activities in nature), but also an increased scarcity for ecosystem services. Second, more demand for ecosystem services has increased the value of GEP with 17 %. In particular, more demand for recreation and living in a green neighborhood were key drivers for a higher GEP. Degradation of ecosystems had a negative effect on the value of GEP, namely a decrease of 1.0 %, which was equal to 106 million euro. Finally, the impact of land use changes had an overall effect of -0.2 %. In particular the decrease of Dunes and coastal area and cropland led to the provision of less ecosystem services in these areas.

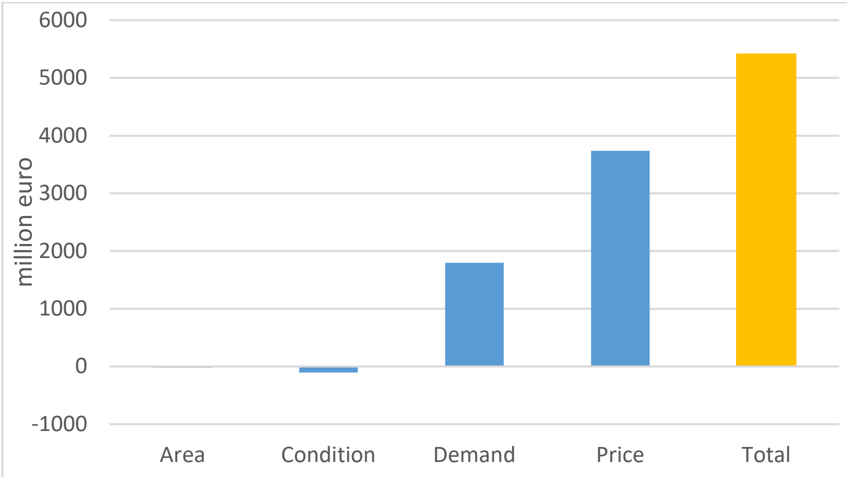

Figure 4.13 Drivers of the total value change of GEP (2013-2021)

GEP versus GDP

The change of GEP over time can be compared to that of GDP (Figure 4.14). As changes in GDP are normally presented in constant prices (economic growth), also GEP is here presented in constant prices. For the Netherlands, GEP and GDP more or less have increased with the same rate in the period 2013-2021. In 2020 GEP decreased more than GDP, but increased more in 2021.

Interpretation: GDP is a measure of the size of the economy with regard to how many goods and services are produced (and used). A change of GDP in time thus indicates whether the size of the economy has increased or decreased. Likewise, GEP is a measure of the size of nature with regard how many ecosystem services are produced (and used by our society). A comparison between GDP and GEP thus indicates whether nature is more or less productive than our economy. Price effects have a large impact on both GEP and GEP. In that regard it is more useful to do this comparison in constant prices instead of current prices. Results for the Netherlands indicate that nature is as ‘productive’ as the regular economy, and/or that final demand for normal goods and services and ecosystem services has increased at the same pace.

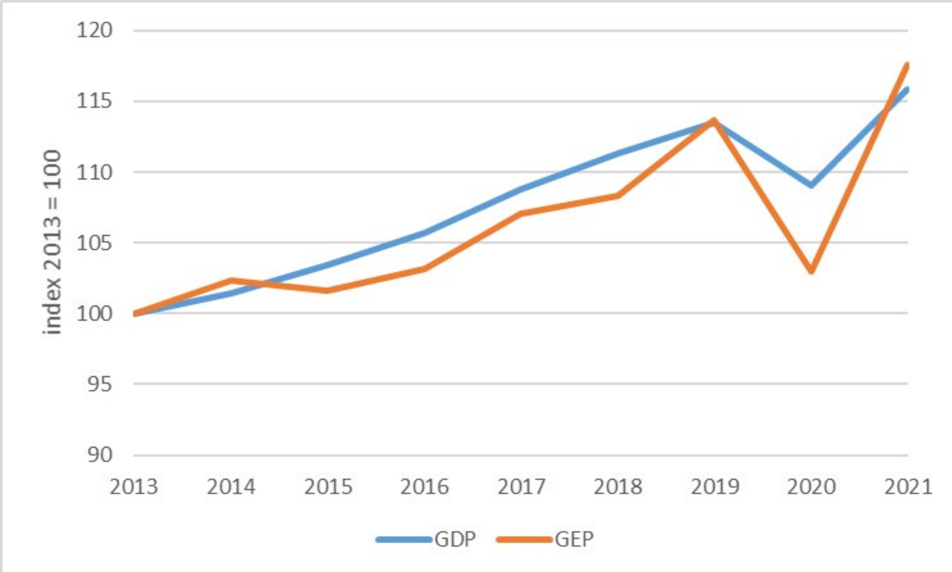

Figure 4.14 Change of GEP and GDP in constant prices

4.6 Comparing monetary ecosystem values with physical data

A final important way to present the data is by comparing monetary ecosystem values with physical data from the SEEA EA accounts, or more specifically with data from ecosystem extent and condition account. Comparisons of this kind are particularly important and informative as they contrast anthropogenic values with non-anthropogenic values. Below we present and discuss two examples.

Figure 4.15 shows in one figure **the distribution of extent and supply of ecosystem services for the main ecosystem types** in the Netherlands. Forests provide most ecosystem services. This is approximately 30 percent of the total value of ecosystem services, while forests only occupy 8 percent of the surface of the Netherlands. Public green space provides 7 percent of the total ecosystem services while in contrast the share in the total surface area is only 4 percent. Additionally, there are ecosystem types that have a large share of the total area, but represent a relatively low monetary value of ecosystem services. This is particularly the case with the built-up environment, such as infrastructure and residential areas.

Interpretation: Semi-natural ecosystem types represent a relatively small share with regard to their extent, but a large share with regard to the ecosystem services they supply.

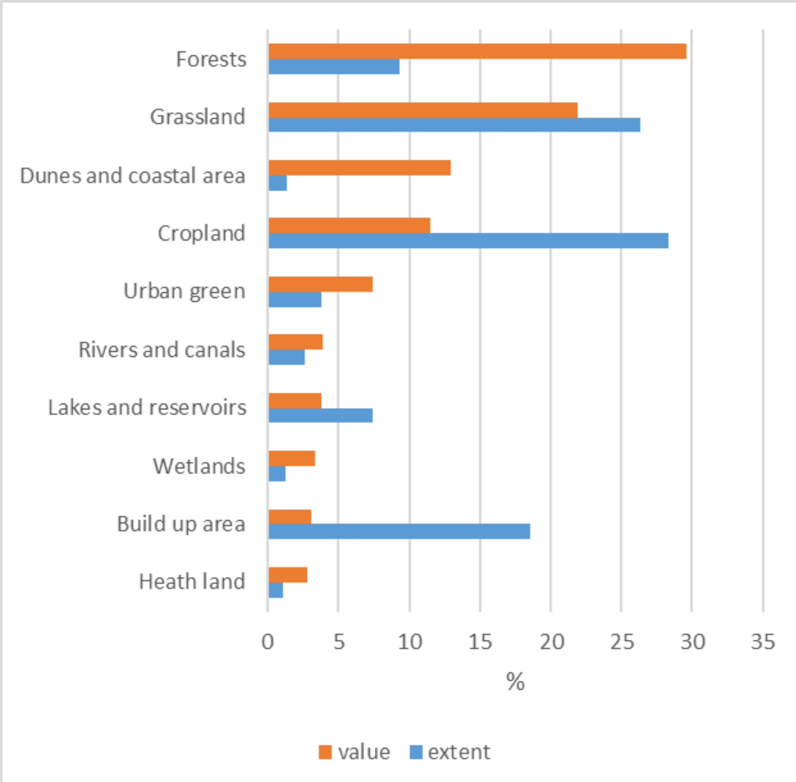

Figure 4.15 Distribution of monetary ecosystem service value and extent over different ecosystem types, 2021

Comparing data for monetary ecosystem values and ecosystem condition, in principle, contrasts two important characteristics of ecosystems. On the one hand, ecosystem condition represents the quality of an ecosystem measured in terms of its abiotic and biotic characteristics (SEEA EA, par. 5.2). Condition is assessed with respect to an ecosystem's composition, structure and function which, in turn, underpin the ecosystem integrity of the ecosystem, and support its capacity to supply ecosystem services on an ongoing basis. Measures of ecosystem condition thus reflect multiple values, including use values, but also non-use values and intrinsic values. On the other hand, as discussed in section 4.1, monetary ecosystem values represent (only) social economic use values.

The condition account provides many different indicators that can be used in this comparison. For example, Figure 4.16 shows for the Netherlands the change in monetary values for ecosystem service supply (in constant prices) and the Living Planet Index (LPI) between 2013 and 2020. The Living Planet Index (LPI) reflects the average trend of almost all native species of breeding birds, reptiles, amphibians, butterflies and dragonflies, as well as a significant part of the mammals and freshwater fish species (Statistics Netherlands, 2022). This is thus an important indicator for changes in biodiversity. Whereas for most ecosystem types the value of ecosystem services supplied increased, the LPI decreased.

Interpretation: The LPI is an important indicator for ecosystem condition. For most ecosystem types we observe that an increase of the provision of social economic benefits by ecosystems does not mean that ecosystem quality also improves. In fact we see the opposite. There is a (partial) disconnect between the 'intrinsic' condition of ecosystems and variables (including demand) determining the supply and use of ecosystem services. For example, we observe that while the ecosystem quality of natural areas in the

Netherlands is deteriorating, still more people may come for recreation. This clearly also supports the notion that monetary ecosystem values are not condition indicators (see section 4.1).

Figure 4.16 Change in monetary values (in constant prices) and the Living Planet Index between 2013 and 2020

5. Conclusions and recommendations

Monetary values for ecosystem services and ecosystem assets can be a powerful instrument for policy makers, researchers, ecosystem managers, etc. These monetary values make explicit that nature provides a considerable contribution to our well-being and represents a considerable wealth. Ecosystems produce substantial and measurable economic value that is not recognized in traditional macro-economic statistics like the SNA. Accounting for these figures also makes explicit that many economic sectors are dependent on the services provided by nature and thus rely on the good health of these natural assets. The key strength of valuing ecosystem services and assets in monetary terms is that it expresses its value in one single unit that a) allows aggregation and comparison of the different variables, i.e. ecosystem services, ecosystem assets etc., and b) by using a monetary metric allows comparisons with other macro-economic variables that are understood universally (expenditures, value added, consumption, investments etc.). As such, monetary valuation is often considered essential for communicating the economic value and scarcity of nature. These features enable the inclusion of these figures and indicators in economic and public decision making.

The strength of monetary valuation is, however, at the same time also its greatest weakness. Assigning a monetary economic value to ecosystems gives rise to a number of ethical and cultural concerns. It can be argued that economic valuation turns nature into a commodity to be used by humans, that efforts to monetize the value of nature detract from its true (intrinsic) value, and that imputed non-market values are misleading. Converting ecosystem data into monetary values enables all kind of comparisons with macro-economic variables and considerations that may not always be meaningful or appropriate, and may lead to misuse or even abuse of these figures. Furthermore, monetary values for ecosystem services that are not scarce, or that are in excess supply, may be low or even zero based on the exchange value concept. Although this is consistent with this value concept, such values should be interpreted carefully and in conjunction with physical supply and use tables; in particular, because non-scarcity can be a result of regulatory policies or market structures, or may reflect the current relative abundance of the ecosystem type supplying the service.

When not presented carefully, economic values for ecosystems can be a source of confusion or even misuse. 'Correct' presentation and positioning of the results is critical. There is thus a heavy responsibility for the compilers of these data to communicate and interpret de results from the monetary ecosystem accounts in a proper manner.

This report provides an overview of the different options how these data can be best presented and disseminated by statistical offices. Based on these results and experiences, but also reiterating work of other organizations in this area (NCAVES and MAIA, 2022; ONS,2023; DEFRA, 2023), we can provide here the following general guidance and recommendations on the dissemination of monetary ecosystem values:

1. **Make clear what monetary ecosystem values represent, but also what they do not represent.** Monetary ecosystem values represent social economic use values, i.e. instrumental values centered on human beings. They thus indicate how much nature contributes to our wellbeing and economy, and/or how much we depend on a healthy environment. Monetary ecosystem values do not convey 'intrinsic values', and thus do not provide insights into the well-being of nature in terms of quality and condition. Also, in principle these monetary values can (in most cases) not be used as sustainability indicators, as the current use of ecosystem services is not always sustainable. Finally, emphasize that the scope of ecosystem services that has been taken into account is not (yet) comprehensive. In that regard, the aggregated values presented should always be viewed as an underestimation.
2. Related to the first point, **always reinforce that monetary values should not be considered to provide, or do not intend to estimate, "the", or "a complete" value of nature**. It is not the purpose to put a price on nature, but rather to make contributions of ecosystems to the economy/society visible and to make comparisons of different ecosystem services and ecosystem assets in a manner consistent with standard measures of products and assets as recorded in the national accounts.
3. **Do not publish standalone monetary figures, but provide them in the right context**. One way to do this is make proper comparisons (see also recommendations below). Always try to provide a proper explanation why certain values are high(er) of low(er).
4. The strength of monetary ecosystem values is that they are all expressed in a common unit. Therefore, when disseminating monetary ecosystem values **a key focus should be on the intercomparibility of monetary ecosystem values** (i.e. compare ecosystem services, ecosystem types, areas, users etc.). This allows the identification which ecosystem services, ecosystem types, areas etc. are more important from an anthropogenic user point of view.

5. In addition, **an important way for dissemination is in providing time series to analyze changes in time**. Here in particular it is important to provide extra context with regard what is causing these changes. Decomposition analysis can be an important tool to determine the drivers of changes in time, namely the effect of changes in area (extent), ecosystem service prices, ecosystem condition and demand for the services. Furthermore, **for time series it is recommended to present the data in constant prices.** Exclusion of the effects of price changes will focus the results on volume and area effects. This is also analogues with the practice in National Accounts data, i.e. focusing on volume changes in for example economic growth.
6. Ecosystem values may be compared to macro-economic variables to assess their importance for our economy. However, extra care must be taken when presenting these comparisons as these in particular are subject to misinterpretation. **In general avoid comparison with macro-economic indicators like GDP, total consumption or exports**. Although conceptually correct, these comparisons are not very meaningful and prone to misinterpretation.
7. **Place emphasis on the fact that a range of both monetary and non-monetary metrics are needed to assess the importance of ecosystems**, and that such assessments may not require compilation of ecosystem accounts in monetary terms. To this end, and to support interpretation of valuation outcomes, it is recommended that when monetary accounts are released, the associated data in physical terms (e.g. concerning changes in ecosystem extent and condition, and flows of ecosystem services in physical terms) are also released. Accordingly, a comprehensive view is provided of the status and trends in ecosystem assets and the ecosystem services they supply.
8. **Disseminating data on both ecosystem flows (services) and stocks (assets) has its merit.** Flows are a measure of (annual) income that is derived from ecosystems, whereas asset values are a measure of wealth. Assets values may be easier to communicate as they make more apparent the economic significance of natural capital (DEFRA, 2023). However, asset values are more uncertain as they are based upon certain assumptions about projected flows, discount rates etc., and may be more subject to misinterpretation (i.e. the total value of nature is….).
9. **Identify and formulate the main message that you want to convey**. Keep it simple and avoid being overly comprehensive in reporting all results that are available. It is important to recognize that the main message is generally in the interpretation or implication of the valuation, not the value estimate itself.
10. Communication and interpretation may be hampered by 'technical correctness'. Valuation of ecosystems is a complex process using technical terminology. Using this terminology may be correct, but may not provide sufficient clarity to the users. **Search for accessible wording and avoid too technical descriptions to convey the correct message.**
11. **Do not only focus on publishing data on the national scale, but also on the regional or local scale.** A key characteristic of SEEA EA is that it is spatially explicit and thus allows the compilation of data on subnational scales. National totals may obscure a high regional variability that may be inherent to the provision of ecosystem services. Maps in particular help to convey the message where there are 'hotspots' with regard to ecosystem wealth. Compilation and dissemination of data on the regional level may also respond to specific user needs, as nature preservation and land management often is executed on a more regional level.
12. **Reach out to potential users and stakeholders to find out what the data needs are with regard to monetary ecosystem values.** This will help to identify what kind of data users need and in what

context. This may also help to clarify how monetary data is currently interpreted and what needs to be done to further improve this.

Compiling and disseminating data from the monetary ecosystem accounts is quite a challenge for statistical institutes. Hopefully, the results of this study may help them overcome the barrier to start working in this area and eventually reporting the data on the monetary ecosystem accounts.

References

Defra, 2023. Enabling a Natural Capital Approach guidance. Enabling a Natural Capital Approach guidance - GOV.UK (www.gov.uk)

De Boer, P. & Rodrigues, J.F.D. (2020) Decomposition analysis: when to use which method?, Economic Systems Research, 32:1, 1-28, DOI: 10.1080/09535314.2019.1652571

Hao, C., Wu S., Zhang W., Chen Y., Ren Y., Chen X., Wang H., Zhang L. (2022) A critical review of Gross ecosystem product accounting in China: Status quo, problems and future directions, Journal of Environmental Management. Volume 322 115995 ISSN 0301-4797 https://doi.org/10.1016/j.jenvman.2022.115995

Hein, L., Remme, R.P. Schenau, S.J., Bogaart, P.W., Lof, M.E., Horlings, E. (2021). Ecosystem accounting in the Netherlands. Ecosystem Services 44.

NCAVES and MAIA (2022). Monetary valuation of ecosystem services and ecosystem assets for ecosystem accounting: Interim Version 1st edition. United Nations Department of Economic and Social Affairs, Statistics Division, New York.

ONS (2023). UK Natural Capital accounts. UK natural capital accounts - Office for National Statistics (ons.gov.uk)

Ouyang, Z. (2020). Using gross ecosystem product (GEP) to value nature in decision making. https://doi.org/10.1073/pnas.1911439117

Pearce, D. and Moran, D. (1994). The economic value of biodiversity. Earthscan, London, UK. 172 pages.

Statistics Netherlands and WUR (2020). Experimental monetary valuation of ecosystem services and assets in the Netherlands. Statistics Netherlands (CBS), The Hague and Wageningen University and Research (WUR), Wageningen.

Statistics Netherlands (2022). Accounting for biodiversity and farmland birds in the Netherlands (2013–2020). Report for the MAIA project.

Statistics Netherlands and WUR (2023). Natural Capital Accounting in the Netherlands - Technical report 2023.

UN (2021). System of Environmental-Economic Accounting-Ecosystem Accounting (SEEA EA) Final draft. United Nations, New York, USA.

Zheng, H., Wu, T., Ouyang, Z. *et al.* Gross ecosystem product (GEP): Quantifying nature for environmental and economic policy innovation. *Ambio* **52**, 1952–1967 (2023). https://doi.org/10.1007/s13280-023-01948-8

Explanation of symbols

Empty cell	Figure not applicable
.	Figure is unknown, insufficiently reliable or confidential
*	Provisional figure
**	Revised provisional figure
–	(between two numbers) inclusive
0 (0.0)	Less than half of unit concerned
2023–2024	2023 to 2024 inclusive
2023/2024	Average for 2023 up to and including 2024
2023/’24	Crop year, financial year, school year, etc., beginning in 2023 and ending in 2024
2021/’22–2023/’24	Crop year, etc., 2021/’22 to 2023/’24 inclusive

Because of rounding, some totals may not correspond to the sum of the separate cells.
Revised figures are not marked as such.

Colofon

Publisher
Statistics Netherlands
Henri Faasdreef 312, 2492 JP The Hague
www.cbs.nl

Prepress: Statistics Netherlands
Design: Edenspiekermann

Information
Telephone +31 88 570 70 70
Via contact form: www.cbs.nl/information