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Valuation of some environmental damages in Georgia

Biodiversity /ecosystem services, water quality and land damage

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About Vista Analyse

Vista Analysis is a social science consultancy with its main emphasis on economic research, policy analysis and advice, and evaluations. We carry out projects to the highest professional standards, with independence and integrity. Our key thematic areas include climate change, energy, transport, urban planning and welfare issues.

Our employees have high academic credentials and broad experience within consulting. When needed we utilize an extensive network of companies and resource persons nationally and internationally. The company is fully employee-owned.

Foreword

Vista Analyse has prepared an overview of valuation methods for environmental damage/impact on biodiversity and water-soil pollution/contamination. The purpose with this is to help the Government of Georgia (GoG) in the implementation of the EU Environmental Liability Directive (ELD). The report presents an outline of the main requirements of the ELD regarding valuation, and discusses the main approaches and methods for valuing environmental damages in monetary terms based on best international practice. The methods and cases in Annex I were presented at a training session for Georgian civil servants 10. – 11. December 2018. Also, a short, practical tip sheet has been prepared to present some practical guidelines for economic valuation.

This project is part of a larger assignment to provide assistance to GoG in development of a package supporting the implementation of the EU Environmental Liability Directive (ELD), financed by grants from the Norwegian Ministry of Foreign Affairs.

Draft reports have been discussed with representatives for GoG. A special thanks to Dr. S. Dhillion, ENVIRODEV, for useful comments. Contact person at ICH has been Carole Rosenlund.

31. December 2018

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Content

1 Introduction

The Terms of Reference (ToR) for this assignment asks for a Consultancy on Valuation Methods for environmental damage/impact on biodiversity and water-soil pollution/contamination. The aim is to assist the Government of Georgia (GoG) authorities who have to make decisions about environmental damage or imminent threat of the same in the hydropower sector and other similar interventions and/or other stakeholders who can be responsible for environmental damage or have an imminent threat of the same.

This project is part of a larger assignment to provide assistance to GoG in development of a package supporting the implementation of the EU Environmental Liability Directive (ELD), including practical guidelines for supporting directives and processes to limit Environmental Liability.

This report presents some simple approaches on how to value the specified damages. It also contains some references to more advanced valuation techniques for those who want to spend more time and resources on these issues. As specified in the ToR, focus is on vegetation, wildlife and fish. Also, the value of biodiversity per se needs to be addressed, since it is important that the biodiversity is available for future generations to provide ecosystem services and other services.

In chapter 2 an overview of the requirements in the ELD is presented. Chapter 3 explains the value of environmental damages in monetary terms. An overview of valuation methods is presented in chapter 4. Chapter 5 goes through how damages on vegetation, wildlife, fish and water could be valued in monetary terms. In Annex I 3 examples (cases) of how to value various damages from various incidents are discussed. Annex II gives an overview of some useful websites for practical monetary valuation approaches.

2 Requirements in the ELD

The aim with the EU Environmental Liability Directive (ELD) 2004/35 EC is to establish a framework of environmental liability, based on the "polluter pays principle", to prevent and remedy environmental damage from occupational activities listed in Annex III of the Directive. The ELD aims at ensuring that the financial consequences of certain types of harm caused to the environment will be borne by the economic operator who caused this harm.

The Government of Georgia (GoG) has prepared a draft law on Environmental Liability that has been considered in this project. The draft law will be put under Parliament review during the first part of 2019.

2.1 Categories of environmental damages in the ELD

There are three categories of environmental damage covered by the ELD:

i) Damages to protected species and natural habitats, i.e. any damage that has significant adverse effects on reaching or maintaining the favorable conservation status of such habitats or species, defined in the relevant parts of the EU Birds Directive 79/409 EC and the EU Habitats Directive 92/43 EC.
ii) Water damage, i.e. any damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential, as defined in the EU Water Framework Directive 2000/60 EC
iii) Land damage, i.e. any land contamination that creates a significant risk of human health being adversely affected as a result of the direct or indirect introduction in, or under land, of substances, preparations, organisms or micro-organisms.

2.2 Remediation is required

Four remediation steps should be considered

Annex II of the ELD sets out a common framework to be followed to choose the most appropriate measures to ensure the remedying of environmental damage. For remediation of *damage to water, protected species or natural habitats* restoration of the environment to its baseline condition should be achieved by way of:

- *Primary remediation*: any remedial measure which returns the damaged natural resources and/or impaired services to, or towards, baseline condition. This could either be on an accelerated time frame or through natural recovery.

- *Complementary remediation*: any remedial measure taken in relation to natural resources and/or services to be implemented when primary remediation does not result in fully restoring the damaged natural resources and/or services. The purpose is to provide a similar level of natural resources and/or services, including eventually at an alternative site (if possible linked geographically to the damaged site), as would have been provided if the damaged site had been returned to its baseline condition.
- *Compensatory remediation*: any action taken to compensate for interim losses of natural resources and/or services that occur from the date of damage occurring until primary remediation has achieved its full effect, either at the damaged or an alternative site. It does not consist of financial compensation to members of the public.
- *Interim losses*: losses which result from the fact that the damaged natural resources and/or services are not able to perform their ecological functions or provide services to other natural resources or to the public until the primary or complementary measures have taken effect. It does not consist of financial compensation to members of the public.

Where primary remediation does not result in the restoration of the environment to its baseline condition, then complementary remediation should be undertaken. In addition, compensatory remediation should be undertaken to compensate for the interim losses.

Remedying of environmental damage, in terms of damage to water or protected species or natural habitats, also implies that any significant risk of human health being adversely affected is removed.

Monetary valuation and cost benefit considerations should be applied

Regarding the determination of complementary or compensatory remedial measures, Annex II says the following (ref. 1.2.2 and 1.2.3):

"When determining the scale of complementary and compensatory remedial measures, the use of resource-to-resource or service-to-service equivalence approaches shall be considered first. Under these approaches, actions that provide natural resources and/or services of the same type, quality and quantity as those damaged shall be considered first. Where this is not possible, then alternative natural resources and/or services shall be provided. For example, a reduction in quality could be offset by an increase in the quantity of remedial measures.

If it is not possible to use these approaches, then alternative valuation techniques shall be used. The competent authority may prescribe the method, for example monetary valuation, to determine the extent of the necessary complementary and compensatory remedial measures. If valuation of the lost resources and/or services is practicable, but valuation of the replacement natural resources and/or services cannot be performed within a reasonable time-frame or at a reasonable cost, then the competent authority may choose remedial measures whose cost is equivalent to the estimated monetary value of the lost natural resources and/or services.

The complementary and compensatory remedial measures should be so designed that they provide for additional natural resources and/or services to reflect time preferences and the time profile of the remedial measures. For example, the longer the period of time before the baseline condition is reached, the greater the amount of compensatory remedial measures that will be undertaken (other things being equal)."

When evaluating the different identified remedial options, primary remedial measures that do not fully restore the damaged water, protected species or natural habitat to baseline or that restore it more slowly can be chosen. This decision can be taken only if the natural resources and/or services foregone at the primary site as a result of the decision are compensated for by increasing complementary or compensatory actions to provide a similar level of natural resources and/or services as were foregone. This will for example be the case when the equivalent natural resources and/or services could be provided elsewhere at a lower cost.

The competent authority is entitled to decide that no further remedial measures should be taken if (ELD section 1.3.3):

- The remedial measures already taken secure that there is no longer any significant risk of adversely affecting human health, water or protected species and natural habitats, and
- The cost of the remedial measures that should be taken to reach baseline conditions or similar level would be disproportionate to the environmental benefits to be obtained.

Regarding *remediation of land damage*, Annex II says the following (ref. section 2.):

"The necessary measures shall be taken to ensure, as a minimum, that the relevant contaminants are removed, controlled, contained or diminished so that the contaminated land, taking account of its current use or approved future use at the time of the damage, no longer poses any significant risk of adversely affecting human health. The presence of such risks shall be assessed through risk-assessment procedures, taking into account the characteristic and function of the soil, the type and concentration of the harmful substances, preparations, organisms or micro-organisms, their risk and the possibility of their dispersion. Use shall be ascertained on the basis of the land use regulations, or other relevant regulations, in force, if any, when the damage occurred.

If the use of the land is changed, all necessary measures shall be taken to prevent any adverse effects on human health. If land use regulations, or other relevant regulations, are lacking, the nature of the relevant area where the damage occurred, taking into account its expected development, shall determine the use of the specific area. A natural recovery option, that is to say an option in which no direct human intervention in the recovery process would be taken, shall be considered."

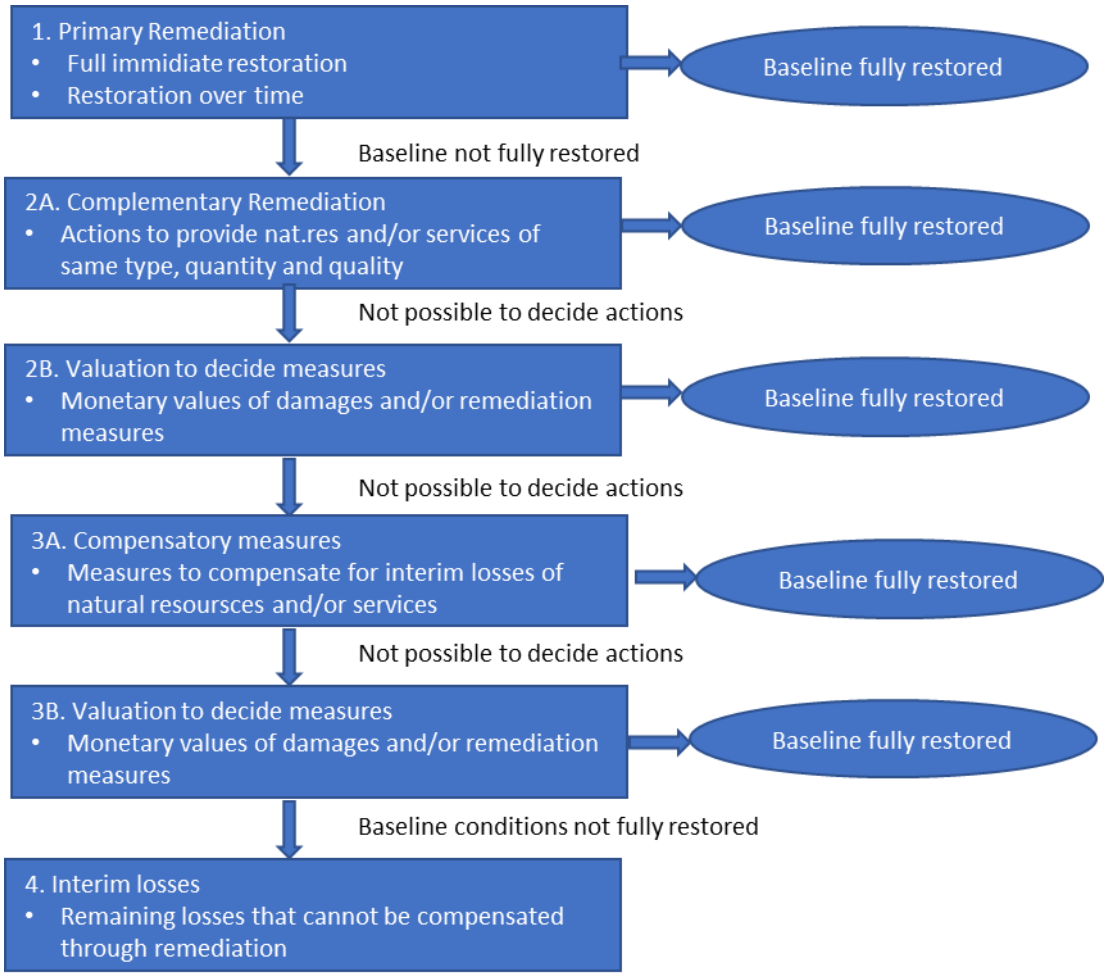
2.3 Summary of ELD requirements

From the outline of ELD requirements some conclusions can be drawn regarding valuation methods for environmental damages/impacts:

- The valuation of damages is to be used in the assessment of what preventive or remedial measures to implement, eventually through a formal cost benefit analysis comparing costs and benefits of the various measures.
- The ELD does not specify the use of any specific valuation methods or approaches to be used.
- The ELD emphasizes the importance of reducing/removing adverse impacts on human health.
- Emphasis should be on local conditions when considering what measures to implement.

Figure 2.1 summarizes the formal steps that is envisaged through the ELD Directive.

Figure 2.1 Steps in ELD remediation assessment



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3 The value of environmental damages

In this chapter we define what economic valuation is, and what it means to value damages to biodiversity/ecosystem service, water and land in economic terms. Our main approach to this is to value the goods and services they provide when not damaged, and then one can use these estimates to value the loss one has when the goods and services are damaged.

3.1 The value of a good or service is what people are willing to pay for it

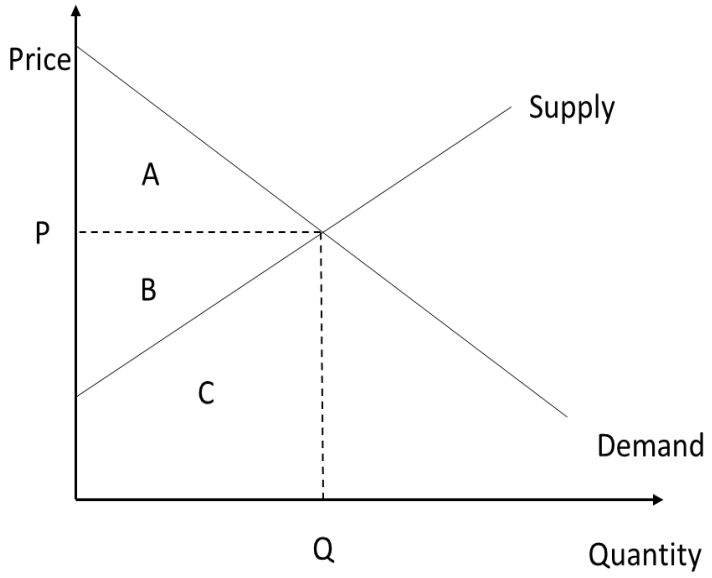
While the value of biodiversity and ecosystem services is the object of interest, it is necessary to make a detour through the valuation of ordinary goods and services.

For goods and services sold in a market the price reflects the marginal value

Every day people make decisions whether to by a good or service or not. Consumers consider the price of a good or service, and compare it with the benefits they might have from it. If the price of the good or service is lower than the anticipated benefits, a consumer will buy an item of the good or service in question. In a market with free competition, the economic value of a good or service is determined by the demand for and supply of that good or service, see figure 3.1. This figure shows a demand and a supply curve for a good or service traded in a market at quantity 'Q' and at price 'P'.

The demand curve shows all buyers/consumers of a good or service in the market. Because buyers tend to buy more when the price is low, the curve is falling as the price is dropping. For producers/suppliers of the same good or service the situation is the opposite, they will produce and sell more when the price increases. Where the curves cross each other at the price 'P', buyers and sellers will buy and sell the same amount ('Q'), and the market is in balance. The buyers' willingness to buy at price 'P' is called their *marginal willingness to pay*, often abbreviated WTP. The sellers' cost of production at 'P' is called *marginal cost.*

Figure 3.1: Definition of producer and consumer surplus



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Consumer surplus is a measure of consumers' gains

Those buyers that are on the part of the demand curve above the market price 'P', want this good or service so much that they are willing to pay more than the market price, i.e. their value of the good or service is higher than P. Because they are able to buy the good or service at a lower price (P) than the highest price they are willing to pay, they have a gain. The total gain obtained by consumers is the area 'A' in Figure 3.1, and is called *consumer surplus* in economic literature.

Producer surplus is a measure of producers' gains

Similarly, the *producer surplus*, depicted by 'B' in the figure, is the amount that producers benefit by selling at a market price that is higher than the lowest price that they would be willing to sell for, which is determined by their production costs and represented by the supply curve. The area 'C' represents production costs, which usually differ among producers and/or over the scale of production.

The welfare value is the total net value of the good or service

The areas A and B can be seen as the net economic gain resulting from production and consumption with a volume of Q at price P. This corresponds to the definition of *welfare value* (UNEP, 2013). A and B are often complicate to calculate, since the calculation requires a lot of data and expertise.

The market price is the willingness to pay for one unit more

As we commented above, the market price (P) reflects consumers' marginal *willingness to pay (WTP)* for one additional unit of the product at the market equilibrium quantity of services Q, Conversely, it reflects their the marginal *willingness to accept (WTA)* one unit less. Valuation often focusses on small, marginal changes, and then the observed price P could be used as the value of the change of one unit (or some few units). For larger changes, when for instance the total amount of good and service disappears, the welfare value should be calculated.

Monetary valuation of ecosystem services is about finding P or the welfare value

Since ecosystem services or other environmental goods and services are usually not traded in markets, one has to find ways of estimating their value. This is what monetary valuation of environmental goods and services is about. Small changes in ecosystem service provision should be valued estimating WTP or finding the price P through various approaches. In cases where the total amount of the good or service is destroyed, one has to try and find the welfare value of the good or service, i.e. A+B in figure 3.1

The *average value* of an ecosystem service or other environmental good can be calculated as its total value divided by the total quantity of the service provided and consumed. Average values may be useful for comparing the aggregate value of an ecosystem service relative to the scale of provision (defined in terms of units of provision, area of ecosystem, or number of beneficiaries).

In the next chapter we go through various ways of estimating or finding P, A and B. As mentioned above A and B are often difficult to estimate or calculate, much of the efforts are on ways of finding P.

3.2 Total Economic Value (TEV) of Ecosystem Services

While there is growing awareness of the value and importance of biodiversity *per se*, there is a lack of consensus on how biodiversity can be defined and measured (Secretariat, 2007). For example, the richness of species is frequently the only accessible indicator of species diversity, although it is well known that a head count of the number of apparently different species in an area may not be a good proxy for the portfolio effect of genetic distance between them. As a consequence, valuation does normally not entail measuring the economic value of biodiversity as such. Instead, valuation typically focusses on the economic values of the goods and services generated by biodiversity resources and/or functions, the so-called ecosystem services. The Millennium Ecosystem Assessment undertook between 2001 and 2005 a comprehensive assessment of the consequences of ecosystem change for human well-being, and analyzed options available to enhance the conservation and sustainable use of ecosystems.

Ecosystem services cover a wide range of services. As they are often not traded on markets, their value cannot be observed in market prices. The reason is that many ecosystem services bear characteristics of "public goods". One important characteristic of public goods is that nobody can be excluded from their use. For this reason, markets for public goods cannot easily develop, and the value of these public goods will therefore not be reflected in a market price (Secretariat, 2007).

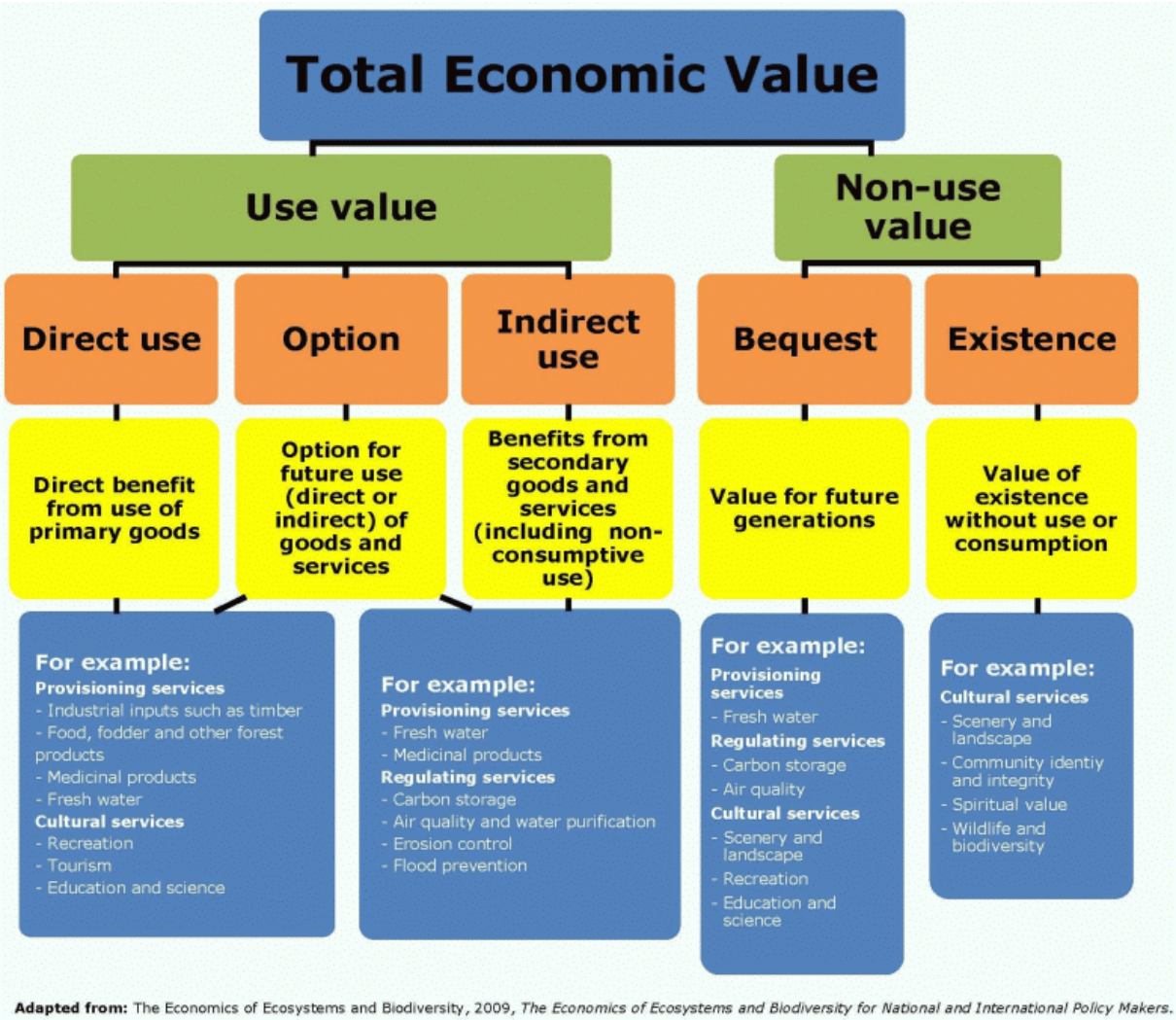
The framework commonly used for describing the different *types* of economic value ascribed to natural resources is known as Total Economic Value (TEV). The framework comprises use values (direct, indirect and option value) and non-use values (bequest and existence values). These types of value are summarized in figure 3.2, and consists of the following (Secretariat, 2007):

- *Direct use value*: this is the value derived from direct use or interaction with environmental resources and services (e.g., timber, fuelwood and recreation are direct use values of a forest). They involve commercial, subsistence, leisure, or other activities associated with a resource. Often the value of these can be derived from prices of products and services sold in the markets
- *Indirect use value:* relates to the indirect support and protection provided to economic activity and property by the ecosystem's natural functions. For example, carbon sequestration is a function of forest ecosystems whose value can be derived from the market price of carbon credits or the avoided costs of having to sequester by other means, or from avoiding the actual effects of warming. Similarly, the watershed protection function of a forest may have indirect use value through controlling water quality and flood drainage that affect downstream agriculture, fishing, water supplies and other economic activities.
- *Option value:* a type of use value that relates to future use of the environment or biodiversity resources and functions. Option value arises because individuals may value the option to be able to use the natural resource sometime in the future. For example, there may be an additional premium placed on preserving a forest system and its resources and functions for future use, particularly if prospects of future value are high and if current exploitation or conversion of a forest is irreversible. The logic of the option motive is to maintain a diverse portfolio of resources as a means to reducing the risk of large fluctuations in value. A more diverse ecosystem also tends to be considerably more resilient. This has been called *insurance value* as well. The lack of knowledge is reflected in the concept of a *quasi-optional value*, referring to the value of having more time to learn about the extent or possible uses of biodiversity, thereby making it possible for future decisions to be based on better information. Decisions should always take into account that the results of an interference with an ecosystem can never be fully predicted.
- *Existence and bequest values:* these are often referred to as "passive" values and are derived neither from current direct or indirect use of the environment. For example, there are individuals who do not use a forest but nevertheless wish to see it preserved because they simply derive utility from the ongoing existence of the ecosystem, or because they wish to conserve it for future generations (*bequest value*). The concrete reasons why they

derive utility may vary and may be based on, for instance, religious, spiritual, or ethical motives. In particular, a non-use motive may coincide with the recognition of a right of existence. In this sense, valuation that is based on the concept of total economic value will also capture, at least to some extent, non-utilitarian values.

The "total" in TEV refers to the aggregation of different sources of value rather than the sum of all values derived from a resource. Accordingly, many estimates of TEV are for marginal changes in the provision of ecosystem services, but "total" in the sense that they take a comprehensive view of sources of value (UNEP, 2013). Of all the value categories, existence or passive value is the most complex one in terms of quantification and valuation.

Figure 3.2 Total Economic Value of Ecosystem Services



Source: Vista Analyse

3.3 Initial steps

Valuation is a process involving several steps (Secretariat, 2007). First, the services being valued must be identified. This includes understanding the nature of the services or goods and their scale (local, regional and/or global, on-site or off-site), and how they would change if the ecosystem changed; knowing who makes use of the services, in what way and for what purpose, and what alternatives they have, and establishing what trade-offs might exist between different kinds of services an ecosystem might provide. The bulk of the work involved in valuation actually concerns quantifying the physical relationships. In many cases, this requires tracing through and quantifying a chain of causality. Valuation in the narrow sense enters in the next step in the process, in which the value of the impacts is estimated in monetary terms.

4 Overview of valuation methods

In this chapter we go through common valuation methods for biodiversity/ecosystem services, water quality and soil pollution/contamination. The overview is based on Secretariat (2007), which is again based on the Millennium Ecosystem Assessment. In accordance with the literature in this field, the main focus is on valuing goods and services provided, which can be used to value the loss when biodiversity, water and land is damaged, and the quantity and/or quality of the goods and services are reduced. An exception is land damage, which is often valued directly. It is often unclear what goods and services land provide directly, but damaged land might have negative impacts on several goods and services by causing damage to water. We include a section on valuing land damage in accordance with the ELD at the end of the chapter.

It is important to note that different valuation methods produce different estimates of economic value that cannot necessary be directly compared. The valuation method, and the amount of economic value it estimates, will have a substantial bearing on the magnitude of the value estimated. It is therefore important to understand what each method or value is and to select a method that is relevant to the actual case. Accordingly, when transferring values from other sites/studies it is important to understand the methods used and the type of values that are produced.

4.1 Two main approaches: revealed and stated preferences

There are two main approaches to economic valuation of ecosystem services and other environmental goods, namely *revealed preferences* and *stated preferences*.

- *Revealed preferences* are based on actual observed behavior data from markets etc., including some methods that deduce values indirectly from behavior in surrogate markets, which are assumed to have a direct relationship with the ecosystem service in question.
- *Stated preferences* are based on hypothetical rather than actual behavior data, where people's responses to questions describing hypothetical markets or situations are used to infer value.

Revealed preferences are generally favored since they reflect actual behavior, but are according to UNEP (2013) limited in their applicability to some ecosystem services. Stated preferences can be costly, complicated and time-consuming to use, but could be more flexible in their application.

4.2 Cost-based approaches are among the most commonly used

One common form of revealed preference estimation is the cost-based method. The cost-based method estimates the costs incurred if the services have to be restored or replaced by various means (Brander et. al., 2016). The main advantage with this approach is that one does not have to value each service (damage) separately, but can instead estimate the costs to bring the services back to baseline conditions. If one is willing to accept these costs, they can be seen as the lowest value assigned to the services (one might have been willing to accept higher costs if

necessary to bring the services back to baseline). To start with these approaches are in line with the requirements in the ELD, see chapter 2.

There are several techniques that can be applied to assess the remediation costs:

- Replacement cost method (RC): costs that the authorities (or the population) are willing to undertake to replace the lost products/services with other means. The estimates could be based on estimates from (local) experts, offers from entrepreneurs or estimate from similar replacement activities in other parts of the country or abroad. For instance, in the case of lost vegetation, costs for implementing alternative actions to restore erosion control and/or flood prevention if appropriate, could be used. This approach fits into the requirements of the ELD (see chapter 2), but could be problematic if the value is to be compared to the remediation costs to decide what and/or to what extent remediation actions should be implemented.
- Avoidance Cost method (AC): costs that the authorities (or the population) are willing to undertake to avoid the loss of products/services. The estimates could be based on costs from similar avoidance activities in other parts of the country or abroad, or offers from entrepreneurs or similar. For instance, costs for cleaning contaminated water to achieve freshwater quality or the costs to supply freshwater from other sources could be an estimate of the value of (lost) freshwater resources. As for RC this approach fits into the requirements of the ELD, but could be problematic when the values are to be used to decide what and/or to what extent remediation actions should be implemented.
- Mitigation/restoration cost method estimates the costs of restoring damaged ecosystem services or mitigating the effects of their loss/damage. The costs could be estimated in a similar way as RC and AC.

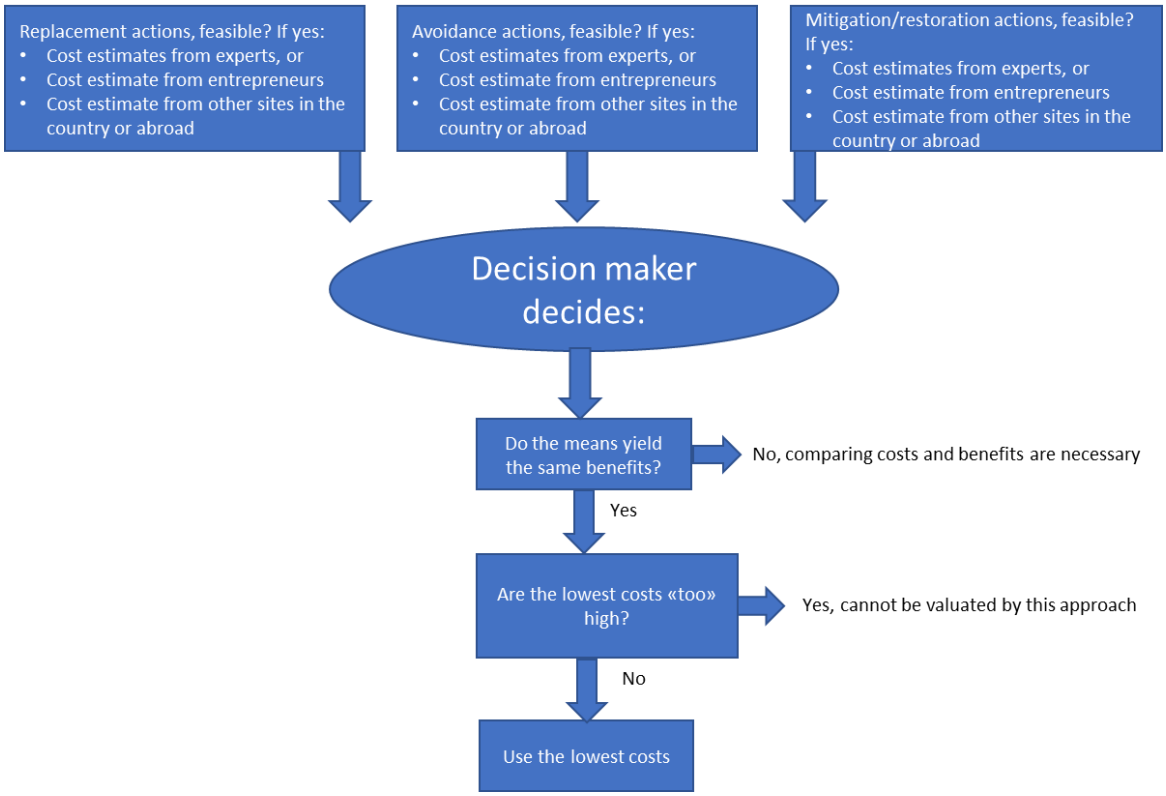
The major underlying assumptions behind these approaches are that the nature and extent of physical damage expected is predictable and that the costs to replace or restore damaged assets can be estimated with a reasonable degree of accuracy. It is further assumed that the replacement or mitigation costs do not exceed the economic value of the service. These assumptions may not be valid in all cases. It simply may cost more to replace or restore a service than it was worth in the first place, for example because there are few users or because their use of the service was in low-value activities.

When there are alternative measure to choose among, It should be considered whether they yield the same benefits. The decision-makers, that could be (local) politicians on behalf of the population, should consider which of the approaches (if all are viable) that yield the highest benefits compared to the costs. When considering this one could for instance look at what costs have been accepted in similar situations in other sites, what are the budget one is facing etc.

Even if there is not necessarily any relationship between the replacement or mitigation cost and the value of the service, cost-based approaches can provide useful guidance in a number of cases, in particular when the specific decision-making problem calls for a comparison of the costs resulting from all different replacement or mitigation options. Then, the valuation challenge is simply to minimize the cost of meeting an objective, by comparing the costs resulting from replacement and mitigation options to achieve for instance a reliable supply of drinking water meeting certain quality standards.

Given the nature of the ELD and the use of the estimated values, replacement, avoidance and/or mitigation costs will be important tools when valuing the various damages. How to use this approach in practice is shown in figure 4.1.

Figure 4.1 Steps in valuating damages using cost-based approaches.



Source: Vista Analyse

In case the cost-based approaches cannot be used to value the damages, and/or there are some remaining damages after the remediation actions are carried out, other approaches will have to be tried, for instance changes in production/productivity. Some interim losses etc. would for instance likely have to be valued by other approaches.

4.3 Changes in production/productivity are often easy to valuate

Reduced availability of water, fish, timber and non-timber products etc. could be valued by market prices

This approach consists of assessing impact of changes in the condition of an ecosystem that can be related to various measures of human well-being or benefits. Such impacts are often reflected in goods or services that contribute directly to human well-being (such as production of timber, fuelwood, non-timber forest products (NTFPs) like mushrooms, berries and other crops, bushmeat, fish or clean water), and as such are often relatively easily valued. The valuation step itself depends on the type of impact but is often straightforward, especially if they are based on goods sold in a market.

For instance, the value of reductions of timber/fuelwood production caused by forest degradation/removal or fish catch resulting from reduced water availability and/or quality are easy to estimate, as these products are often sold. The value can then be estimated as the market price multiplied by the (estimated) loss of quantity, subtracting the production costs. According to Secretariat (2007) it is a very common error to use the reduction in the gross value rather than the net value, i.e. "forgetting" to subtract the production costs.

When the impact is on a good or service that is not sold in the market or where observed prices are unreliable indicators of value, the valuation can become more complex. Using as an example drinking water supply, the prices charged to consumers for water consumption are typically not reliable measures of the value of the water to consumers, as they are often set administratively, with no regard for supply and demand (in many cases water fees do not even cover the cost of delivering the water to consumers, let alone the value of the water itself).

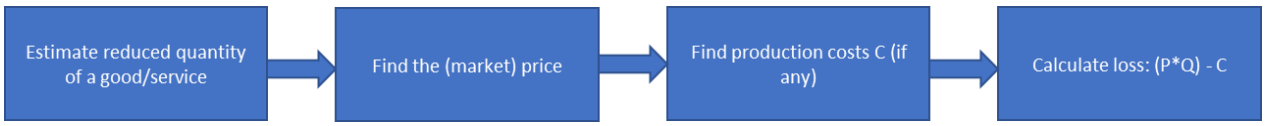
The value of an additional unit of water, fish or timber/fuelwood can be estimated in various ways, such as the cost of alternative sources of supply (cost-based measures are described above) or asking consumers directly how much they would be willing to pay for it (contingent valuation, described below). Note that it is very important to use the value of an *additional* unit of the good, which will be very valuable when it is scarce, but much less so when it is plentiful. This shows that average numbers can be misleading.

Reduced quality of goods and services are more difficult to valuate

When the impact is on water-, fish- or even timber- and non-timber-products' *quality* rather than *quantity*, these impacts on well-being should be valuated as well. Reduced quality of water and fish could result in increased morbidity or even mortality. The process begins by tracing through chains of impacts, for example by using dose-response functions that tie concentrations of pollutants to human health. Valuing the impact on health itself can then be done in a number of ways (see cost of illness and human capital below).

In some cases, the impact from changes in ecosystem services is on fairly intangible aspects of well-being, such as aesthetic benefits or existence value. Particular valuation techniques exist to value such impacts, including hedonic price, travel cost, and contingent valuation methods, see below.

Figure 4.2 How to estimate changes in production of a good or service



Source: Vista Analyse

4.4 Cost of illness and premature death are likely not that relevant in an ELD context

Direct out-of-pocket costs are relatively easy to use, but will likely underestimate the damages

The economic costs of an increase in morbidity due to increased pollution levels of for instance drinking water and fish can be estimated using information about costs associated with the increase: any loss of earnings resulting from illness, medical costs such as for doctors, hospital visits or stays, medication and other related out-of- pocket expenses. The estimates obtained in this manner are interpreted as lower-bound estimates of the presumed costs or benefits of actions that result in changes in the level of morbidity, since this method disregards the affected individuals' preference for health versus illness and restrictions on non-work activities that illness often impose on people. Also, the method does not recognize that individuals may undertake defensive actions (such as using special water filtration systems to reduce exposure to pollution) and incur costs to reduce health risks. If this is the case, the treatment costs may be a better measure of the damages (see below).

Methods to estimate mortality are complex and often controversial

When the abovementioned approach is extended to estimate the costs associated with pollution-related mortality (death), it is referred to as the human-capital approach. It is similar to the change-in-productivity approach in that it is based on a damage function relating pollution to productivity, except that in this case the loss in productivity is that of human beings, measured in terms of expected lifetime earnings. Because it reduces the value of life to the present value of an individual's future income stream, the human-capital approach is extremely controversial when applied to mortality. Many therefore prefer to use other approaches like Value of Statistical Life (VSL) or measures such as disability-adjusted life years.

VSL is based on individuals' willingness to pay (WTP) for a reduction in the risk of death. VSL can for instance be derived from observations of costs of measures to reduce the risk of premature death imposed by society in other cases, for instance costs of actions to reduce (the damages from) traffic accidents. For instance, the number of premature deaths from inadequate water supply could be estimated from so-called dose response functions (also called exposure-response), which are relations between impacts on deaths from various exposures of a pollutant or similar derived from scientific studies.

Disability-adjusted life years (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. DALY=Years lived with disability (YLD) + Years of life lost (YLL). DALYs are calculated by combining measures of life expectancy as well as the adjusted quality of life during a burdensome disease or disability for a population. DALYs are related to the quality-adjusted life year (QALY) measure, however QALYs only measure the benefit with and without medical intervention and therefore do not measure the total burden. Also, QALYs tend to be an individual measure, and not a societal measure. There are several examples in the literature on how DALYs could be calculated.

4.5 Hedonic pricing is not so applicable

The prices paid for goods or services that have environmental attributes differ depending on those attributes. Thus, a house in a clean environment will have a higher price than an otherwise identical house in a polluted neighborhood. Hedonic price analysis compares the prices of similar goods to estimate the implicit value (also called "shadow price") that buyers place on the environmental attributes. This method assumes that markets are transparent and work reasonably well, and it would not be applicable where markets are distorted by policy or market failures. Moreover, this method requires a very large number of observations, so its applicability is limited.

4.6 Travel cost method has limited use

This method is an example of a technique that attempts to deduce value from observed behavior in a surrogate market. It uses information on visitors' total expenditure to visit a site to derive their demand curve for the site's services. From this demand curve, the total benefit visitors obtain can be calculated. It is important to note that the value of the site is not given by the total travel cost, this information is only used to derive the demand curve. This method was designed for and has been used extensively to value the benefits of site-seeing or of recreation at particular sites, but it has limited utility in other settings. The method could be used when calculating the value of recreational services from ecosystems.

4.7 Contingent valuation (CV)

CV is costly and time-consuming to use

CV is an example of a stated preference technique. It is carried out by asking consumers directly about their willingness-to-pay (WTP) to obtain an environmental service. A detailed description of the service involved is provided, along with details about how it will be provided. The actual valuation can be obtained in a number of ways, such as asking respondents to name a figure, asking them whether they would pay a specific amount or having them choose between options that differ in both quality and cost.

CV can, in principle, be used to value any environmental benefit simply by phrasing the questions appropriately. Moreover, since it is not limited to deducing preferences from available data, it can be targeted quite accurately to ask about the specific changes in benefits that the change in ecosystem condition would cause. Because of the need to describe in detail the service being valued, interviews in CV surveys are often quite time-consuming. It is also very important to identify the relevant population, to ensure representativeness of the sample of respondents, and to have the questionnaire extensively pre-tested to avoid sources of bias.

A potentially important limitation when applying the CV method to ecosystem services is that respondents cannot typically make informed choices if they have a limited understanding of the issue in question. Choosing the right approach for, and the adequate intensity of efforts

in improving the understanding of biological complexity of the sample group is a challenge for stated preference methods.

CV has some weaknesses, but most of them can be overcome

CV methods have been the subject of severe criticism by some analysts, in particular because a number of biases can occur that would lead CV-studies to not reflect true preferences:

- One major issue is that of so-called zero-bids, that is, respondents that say they have no willingness-to-pay at all. In some cases, such an occurrence can be explained by that the service in question is not valued by the respondent or his/her budget restrictions are too tight. However, zero-bids can also reflect protest, respondents who are not agreeing that they should pay for the service in question and who consider someone else responsible, for instance the government or the polluter. A zero-response may also be given when no trade-offs for the service are accepted at all. Finally, protest bids can also occur when the survey itself is rejected as a methodology, or payment alternatives are not accepted.
- Exaggerated willingness-to-pay statements are possible as well, for different reasons: (i) The phenomenon of "yes-saying" has been shown to occur sometimes, respondents will agree to a proposal or bid to please the interviewer or avoid further questions. (ii) The existence of a "warm glow" can also have an influence; respondents tend to feel good about giving, about being "good" or "nice", and will initially offer higher a willingness-to-pay than after thorough consideration. (iii) Strategic behavior can also occur: participants will state unrealistic willingness-to-pay numbers in an attempt to influence the outcome of the study. (iv) Willingness-to-pay statements tend to also be elevated due to a lack of awareness of possible substitutes.
- Another source of bias can be through the interviewer giving information that is not fully neutral, or formulating questions to favor certain answers.

The most renown CV on environmental damage is the one used after the 1989 Exxon Valdez oil spill. A "blue-ribbon" panel was organized by in the United States following controversy over the use of CV in this case. The report of this so-called NOAA panel (Arrow et al. 1993) concluded that contingent valuation can provide useful and reliable information when used carefully, and it provided guidance thereon that can help to reduce or avoid many of the biases described above. This report is generally regarded as authoritative on appropriate use of the technique.

The guidance of the panel includes *inter alia* the following requirements:

- The design of CV studies should be conservative, always rather allowing for an underestimate than an overestimate of willingness-to-pay.
- Because the concept of willingness-to-accept is a source of potential bias, willingness-to-pay should be preferred over willingness-to-accept.
- The valuation questions are to be asked as a vote on a referendum, not completely open.
- Sufficient information must be provided, however care is necessary in the use of pictures, including the pre-testing their effect on participants, and possibly making another choice.

- Participants should be made aware of substitutes for the good being evaluated.
- Sufficient time should pass after a negative impact on the ecosystem before a contingent valuation study is conducted in order to avoid answers out of a momentary disposition. Answers averaged over several points in time can avoid catching temporary changes in preferences.
- Respondents should be able to refuse an answer, with an attempt to be made of finding out the reasoning behind both refusals to answer and yes/no answers.
- A high-quality survey would also include questions on socioeconomic data and respondents' general attitudes and perceptions of the issue at stake, with the influence of these variables on the willingness-to-pay being analyzed.
- Lastly, with all the above guidelines met, the questionnaire must still be easy enough to understand and not take an excessive amount of time to complete.

So-called dichotomous or polychotomous choice is a variant of CV where instead of open questions the respondents are asked whether they would pay a certain amount. Dichotomous choice allows only for "yes" and "no" answers, polychotomous choice provides more options such as "probably pay", "certainly pay" or "not sure". Questions can be single-bounded, where only one question is asked, or multiple-bounded, where follow-up questions with higher or lower amounts, depending on the initial reply, are asked. There are usually different versions of a questionnaire with different amounts being initially offered for choice. This technique makes answering easier for respondents, thereby reducing the chance of unrealistic statements. It does however bear the risk of starting point bias, that is researchers influencing outcomes by choosing certain starting points.

For further reading about CV, design of survey etc.: see OECD Handbook on Biodiversity Valuation (2002).

4.8 Choice Experiments could be useful, but are complex to use

Choice experiments (also referred to as contingent choice, choice modelling, conjoint analysis, or attribute-based stated choice method) is a newer approach to obtaining stated preferences. It consists of asking respondents to choose their preferred option from a set of alternatives where the alternatives are defined by attributes (including the price or payment). These approaches are useful in cases where we are interested in the valuation of the attributes of the situation or when the decision lends itself to respondents choosing from a set of alternatives described by attributes.

Choice experiments has several advantages: the control of the parameters is in the experimenter's hand, as opposed to the low level of control generated by real market data, the control of the design yields greater statistical efficiency, the attribute range can be wider than found in market data and the introduction or removal of products, services and attributes is easily accomplished. The method also minimizes some of the technical problems associated with CV, such as strategic behavior of respondents. The disadvantages associated with the technique are that the responses are hypothetical and therefore suffer from problems of hypothetical bias (similar to

CV), and that the choices can be quite complex when there are many attributes and alternatives. The econometric analysis of the data generated by choice modelling is also fairly complex.

4.9 Benefits (value) transfer is very useful, but must be used with care

4.9.1 Must make sure that the circumstances are similar

Benefits or value transfer is not a methodology *per se,* but rather refers to the use of estimates obtained (by whatever method) in one context/site (study site) to estimate values in a different context/site (policy cite). For example, an estimate of the benefit obtained by tourists viewing wildlife in one park might be used to estimate the benefit obtained from viewing wildlife in a different park. Alternatively, the relationship used to estimate the benefits in one case might be applied in another, by using adjusted data from this case together with some data from the site of interest (this is called "benefit function transfer"). For example, a relationship that estimates tourist benefits in one park, based in part on their attributes such as income or national origin, could be used in another park, but with data on income and national origin of that park's visitors.

Estimates based on benefits transfer can be generated with considerably less time and resources than primary studies, and is often used in valuation of ecosystem services and similar goods. Benefits transfer has been the subject of considerable controversy in the literature, as it has often been used inappropriately. According to the Millennium Ecosystem Assessment, a consensus seems to be emerging that benefit transfer can provide valid and reliable estimates under certain conditions. These conditions include the requirement that the commodity or service being valued is very similar to the site where the estimates were made, and the site where they are applied and that the populations affected have similar characteristics. Of course, the original estimates being transferred must themselves be reliable for any transfer to be meaningful. But as the conditions at two sites are unlikely to be perfectly identical, some transfer error is to be expected. It should be recognized that the determinants of both the supply and demand of ecosystem services are spatially variable, which makes the assessment and transfer of ecosystem service values inherently spatial.

The number of primary studies on the value of ecosystem services is substantial and is growing rapidly. This means that the benefits transfer can be based on multiple primary studies.

However, benefit values should be adjusted for differences between the study and policy site. These are elaborated below.

4.9.2 Adjustments for differences in income level should be made

The demand for most goods and services, including ecosystem services, changes with income. Generally, as income rises, the demand for and value of "normal" goods and services also increases. When transferring values for ecosystem services from countries or areas with different incomes it is therefore necessary to adjust for the effect of income on the demand and value of ecosystem services. Ideally, such adjustments should use measures of individual or household

income. Adjustments for differences in income between study sites and policy sites can be made using information on how the willingness-to-pay (WTP) for the ecosystem service in question changes with respect to income. The economic term for this is the "income elasticity of WTP". This is a measure of how much the WTP for an ecosystem service changes with income, and is generally expressed as the percentage change in WTP for a one percentage point change in income. Estimates of the income elasticity of WTP for different ecosystem services can be available from primary valuation studies and meta-analyses that include income as an explanatory variable in estimated value functions. UNEP (2013) present as an example of estimates of the income elasticity of WTP for wetland ecosystem services from recent meta- analyses in the range 0.295 - 1.16.

The formula for unit value transfer adjustment is:

$$WTP_p = WTP_s(Y_p/Y_s)^E$$

Where:

WTP_p = willingness to pay at the policy site ("our" site)

WTP_s = willingness to pay at the study site

Y_p = income per capita at the policy site

Y_s = income per capita at the study site

E = income elasticity of willingness to pay

When using value estimates from other parts in the country one does not usually adjust for differences in income level, unless income levels vary considerably. When information on the income of beneficiaries is not available (as is often the case), one can use information on Gross Domestic Product (GDP) per capita as a proxy for income. This is the main approach when using estimates from other countries, as data on GDP per capita for countries are easily available.

The income elasticity E is often not easily available in the literature. In this case the adjustment is often made by multiplying the value from the study cite with the relation Y_p/Y_s, implicitly assuming that the elasticity is 1. While this is generally not a correct estimate of E in most cases, it is an omission that could be accepted if one for instance shows the impacts on the estimate of higher and lower values of E.

4.9.3 Year of value and general price level must be adjusted for

Value estimates from primary valuation studies are reported at the general price level for a particular year, usually (but not always) the year in which the study was conducted. For example, a valuation study conducted in 1995 is likely to report values in the price level in that year. Inflation, however, causes general price levels in a country to rise over time so that any given amount of money is worth less over time in terms of the goods and services that it can purchase.

When transferring study site values that were estimated in previous years to inform a current policy decision (and to compare transferred ecosystem service values with other values that are relevant to the policy decision), it is necessary to adjust values to account for inflation. All values should be adjusted to ensure that they represent the general price level of the same year. This can be done using available

domestic price indices or GDP deflators that measure the annual rate of price change in an economy. GDP deflators are available for instance from the World Bank World Development Indicators (http://data.worldbank.org/data-catalog/world-development-indicators).

The formula for this adjustment is:

$$WTP_P = WTP_S(D_P/D_S)$$

Where:

WTP_P = willingness to pay at the policy site

WTP_S = willingness to pay at the study site

D_P = GDP deflator index for the year of the policy site assessment

D_S = GDP deflator index for the year of the study site valuation

4.9.4 Purchasing power and currency also differ between countries

General prices for goods and services vary across different countries and even within countries, reflecting differences in the costs of production and demand. Differences in the general price level across countries are measured using price indices, which compare prices for a representative basket of consumer goods in each country. When comparing across countries with different price levels, a given amount of income will be able to purchase more goods and services in a country with a lower general price level than in a country with a higher general price level. For example, someone earning USD 750 in Georgia would need to earn USD 1000 in the United States to be able to buy the same quantity of goods and services if prices are generally 33 percent higher in the United States.

This means that it is not valid to directly transfer values between countries with different price levels, since the same amount of money represents a different quantity of goods and services (and therefore utility for the consumer). It is therefore necessary to make adjustments to values when transferring from one country to another.

Transferring values from a study site in one country to a policy site in another country also need to account for that most countries have their different currencies, and so values need to be converted to the appropriate currency as well as price level. Primary valuation studies generally report values in the currency of the country in which the study site is located, and often also in US dollars (USD) if the results are intended for an international audience.

To transfer values between countries involves using purchasing power parity (PPP) adjusted exchange rates, which are also available for all countries in the World Bank World Development Indicators (https://data.worldbank.org/indicator/PA.NUS.PPPC.RF). The formula for this adjustment is:

$$WTP_P = WTP_S \times E$$

Where:

WTP_P = willingness to pay in currency of the policy site

WTP_S = willingness to pay in the currency of the study site

E = purchasing power parity adjusted exchange rate between policy and study site currencies

In cases where the study site value estimate is reported in a second currency (often USD) that has been calculated using a standard market exchange rate, it is necessary to adjust this reported value to reflect differences in price level. This involves converting the value reported in USD into the local currency using the market exchange rate (ideally the rate that was used by the analyst for the primary study) and then converting it into the desired currency using a PPP adjusted exchange rate. If the standard market exchange rate is not reported in the primary study, market exchange rates are available in the World Bank World Development Indicators or any other website reporting exchange rates. For example, the WB indicator shows that in 2017 0.38 Georgian lari (GEL) would buy the same amount of goods and services in Georgia as would 1 USD in the US.

4.9.5 Other benefit transfer challenges

Cultural differences should be considered

Different people and cultures can have very different perceptions, preferences and values for ecosystem services. For example, patterns of outdoor recreational activities in natural areas are observed to be very different across countries. More fundamentally, ecosystems can have strong cultural significance in some societies and not in others. Differences are most likely smallest between neighboring countries. Transferring ecosystem service values from one cultural context to another can therefore be problematic. Cultural considerations should be reflected in the selection of relevant primary valuation studies from which values are transferred. In cases of specific cultural significance and customs related to ecosystems, however, the scope for using value transfer may be limited and primary research is the only valid valuation approach.

Local scarcity of a good or service should be considered and eventually adjusted for

As a good or service becomes scarce, its price or marginal value increases. The local scarcity or abundance of an ecosystem service is therefore a potentially important determinant of its value. For example, the value of water supplied by a wetland is likely to be considerably higher in an environment with low water availability than one in which water is abundant (setting aside other factors). It is therefore necessary to consider and eventually adjust for differences in the relative scarcity of the resource or ecosystem service being valued.

The availability of substitutes or complementary resources should also be considered

Similarly, differences in the availability of substitute or complementary resources should be controlled for. Substitute ecosystems are alternative sources of the same service. For example, parks and green spaces within a city can be used for recreation activities and may be direct substitutes. The consequence of disregarding substitutes is generally an overestimation of WTP, as the sum of the value of ecosystem services measured individually is higher than the value measured for all ecosystem services at once.

Complementary ecosystems are those that when combined provide a greater quantity or quality of an ecosystem service. For example, systems of coastal and marine ecosystems that include mangroves, seagrass and coral reefs support commercially important fish species that depend on each habitat at different stages in their lifecycle (UNEP, 2013). The presence of complementary ecosystems in a locality may enhance the value of an ecosystem service, and this should be reflected in transferred values. Disregarding complementary sites is likely to result in underestimation of WTP.

The unit of the valuation must also be taken into account

Value transfers that use values per beneficiary involves identifying the appropriate number of beneficiaries for the ecosystem service in question. In other words, how many individuals or households hold values for the ecosystem service and are affected by the change in provision? For value transfers that use values per unit of ecosystem area, it is important to identify the relevant area over which to aggregate unit values. For example, this might be the area of a forest converted to agricultural land or the area of restored wetland in a floodplain. Generally, most policy decisions will result in relatively small or marginal changes to areas of ecosystems. Very rarely will a policy decision involve the total loss of an ecosystem. It is therefore necessary, and more useful for the decision maker, to identify and value the specific area that is impacted by the policy decision. This information may be obtained from technical reports, inputs from experts, or through stakeholder consultation.

For further reading about practical ways of adjusting benefit transfer estimates, see UNEP (2013).

4.10 Summary and recommendations

Primary valuation techniques could be time consuming and costly to use

According to Secretariat (2007) it appears that, when applied carefully and according to best practice, valuation tools can generally provide useful and reliable information on the changes in the value of non-marketed ecosystem services that result (or would result) from management decisions or from other human activities. Data requirements may be quite demanding for a number of tools, as are the preconditions in terms of technical expertise. Moreover, conducting primary valuation studies like CV is typically time-consuming and costly, and require expertise to design the study, carrying out the survey and analyzing/presenting the results.

Approaches based on observed behavior should be preferred

When valuating ecosystem service and environmental damages, we prefer using data based on *observed behavior*, i.e. revealed preferences instead of stated preferences. This is also in accordance with the recommendations of the Millennium Ecosystem Assessment. When using revealed preferences one tries to observe (reveal) what people actually pay under similar circumstances etc. to prevent or avoid the damages in question, instead of asking people what their willingness to pay is for the actual services or measures. Revealed preferences tend to give more accurate estimates of the WTP, and are also easier and cheaper to use than WTP surveys and similar approaches. Therefore, we recommend that the approaches are based on revealed preferences. These are generally not

very costly or time-consuming to carry out, and do not necessary require expertise in any particular field as long as the physical impacts are assessed and described, though some knowledge of basic economics would be useful.

The cost-based approaches and change in production/productivity are most commonly used

The various cost-based approaches, valuating the damages at the restoration, removal or avoidance costs. When using this approach one should bear in mind that this could underestimate the value since people or the authorities could have been willing to pay higher costs if necessary to restore or avoid the damages.

The change in production/productivity approach is applicable to a wide range of direct and indirect use values and most commonly used.

Several techniques have been specifically developed to cover the characteristics of particular problems. The travel cost method, for example, was specifically developed to measure the utility derived by visitors to sites such as protected areas, and could also be applied to similar areas of interest, but is of limited applicability outside that particular case. It is time-consuming and costly to use, and requires some expertise to be carried out properly.

Contingent valuation is necessary to estimate non-use values

Contingent valuation is potentially applicable to any issue, simply by phrasing the questions appropriately. As such it has become very widely used (according to Secretariat (2007) probably excessively so), as it is easy to misapply and, being based on hypothetical behavior, is inherently less reliable than measures based on observed behavior. For instance, if the focus is on the quantification of indirect use values, the application of other valuation tools would often seem to be preferable. For some types of value, however, stated preference methods may be the only alternative. Thus, existence value can only be measured by stated preference techniques like CV. As mentioned, this is often very time-consuming and costly to carry out, and need expertise in economics and/or other social sciences to be carried out properly. Guidance on the appropriate use of the technique exists and should be followed closely, see above.

Benefits transfer approaches are cost efficient to apply, but should be used cautiously

Benefits transfer can provide valid and reliable estimates under certain conditions. Given the cost of undertaking primary valuation studies, benefits transfer when used cautiously is likely to be an increasingly appealing way for extending the use of valuation, including in developing countries and countries in transition. This approach is not very time-consuming or costly to carry out, but likely need some knowledge on economics to be carried out properly. It is often the approach that “saves” the valuation if there are no site-specific data available, and collection such data is not a viable option.

4.11 Valuation of land damage

The focus on land damage in the ELD is on human health impacts from new project interventions (i.e. interventions after 2007). In the literature and practical valuation the main focus have been on cleaning up contaminated sites, where for instance industries over many years have dumped chemicals and various waste that have leaked into the ground and eventually also nearby water. One way soil pollution can harm humans is through bioaccumulation. Plants that are grown in polluted soil absorb the pollutants. Animals who eat many of these polluted plants take on all the pollution those plants have accumulated. Larger animals who eat the plant-eating animals take on all the pollution from the animals they eat. Humans who eat plants or animals that have accumulated large amounts of soil pollutants may be affected.

Various exposures of soil contamination have led to long-term, low-level (chronic) exposure to several harmful pollutants (heavy metals, persistent organic chemicals, oil spill etc.) for humans, leading to for instance cancer, neurological damage, kidney disease (EC, 2013). Current pollution could also contribute to this. The relation between soil contamination and long-term human health is complicated and not so well understood as pollution to air and water. Impacts of high levels (acute) soil contamination around the world have also been studied, and the causes and effects are often relatively straightforward to determine, but there are few if any of these in Europe.

Thus, we are facing a challenge when valuating human health impacts from new, potential land damage or contamination. One way could be to use previous valuations of contaminated sites to illustrate what the long-term impacts might be, given that new sites are allowed to be established and leak pollutants into the ground and/or water. The valuation methods to use could be similar to those used for valuating health impacts from contaminated water, i.e. dose response relations and VSL. Observed treatment costs could be a first step.

5 Valuing vegetation, wildlife, fish and water damage

In this chapter we go through various practical approaches when estimating the damages caused to the various ecosystem goods and services obtained from vegetation, wildlife, fish and water. Again, the approach is to show how to value the goods and services provided, and then to see how the loss of these goods and services could be valued. At the end of the chapter we present some examples on how the economic values of reduced quantity and/or quality of some goods and services could be found.

5.1 Start with the steps required by ELD, and estimate the remediation costs

Figure 2.1 shows the main remediation steps that should be taken to restore the damaged site, replacement site or similar back to baseline conditions, i.e. how it was before the damage was done. Four steps are eventually required, depending on to what extent each step is able to restore the site.

Then the damages will be indirectly valuated through the costs of the various remediation measures that are deemed necessary. If the site and the ecosystem services it provides is then fully brought back to baseline conditions, then there should be no more damages to valuate and the value of the damages is then implicitly valued at remediation costs. However, as mentioned in chapter 4 this may underestimate the actual damages or value of the ecosystem services.

It may seem unlikely that a damaged site is fully restored back to baseline conditions. Most often there will still be some damages left that could eventually be valuated, depending on what kind of damage and if they are large enough to have any significant value. Besides, remediation could take time, and during that time there would likely be some damages to at least the direct and indirect use of the ecosystem services. The impacts on these uses should be estimated in physical terms and valuated, using the most appropriate approaches described in previous chapters.

5.2 Overview of services and valuation approaches

Separate between use and non-use values

According to the ToR biodiversity (vegetation, wildlife and fish) and water quality should be core foci of the work. Below is an outline of some of the services and values that could potentially be linked to these.

Table 5.1: Goods and services from vegetation, wildlife, fish and water

Use Values			Non-use values
Direct Use Values	Indirect Use Values	Option Values	Existence values
Vegetation	Flood and landslide protection		Biodiversity as such-Culture, heritage
Fuelwood	Carbon sequestration	Potential future uses	
Timber	Flood and landslide control	Potential future uses	
Non-timber forest products (NTFPs)	Water filtering	Potential future uses	
Recreation and tourism		Potential future uses	
Esthetic value		Potential future uses	Culture, heritage
Peat harvesting	Groundwater regulation and protection, methane storage	Potential future uses	Culture, heritage
Beekeeping	Pollination	Potential future uses	Biodiversity as such
Wildlife			Biodiversity as such
Hunting		Potential future uses	
Recreation and tourism		Potential future uses	
Fish			Biodiversity as such
Fishing		Potential future uses	Biodiversity as such
Recreation and tourism		Potential future uses	
Water quality			
Drinking water quality		Potential future uses	
Water quality for other purposes	Fish farming, irrigation, bathing etc.	Potential future uses	

Source: Vista Analyse

Use values and likely also option values can be estimated through observed prices of goods and services

Bearing in mind the recommendations above, the preferred and likely only viable approach would be to value the various direct and indirect use values using the revealed preferences approach, i.e. using observed market prices of the various goods and service to the extent possible.

The option value of biodiversity for future generations can also likely be valued by estimating the future values of the ecosystem services that could be provided. Thus, this valuation can then use the same approach as the estimation of the current use values, eventually adjusting these values and calculate a present value of the estimates using an appropriate discount rate. Through this approach it will be possible to estimate some of the future option values, likely the most important ones.

Eventually, if market prices do not exist or are hard to find, benefits transfer could also be used. Then one has to be very careful to adjust these data to reflect local conditions at the cite that are to be valued.

Non-use values must likely be valuated through contingent valuation techniques or benefit transfer

As mentioned in chapter 4 there are most often no market data that can be used to indicate the non-use value of a site. CV and other approaches can be used, but are often not a viable approach because they are time-consuming, costly and require expertise. Then one must look for valuation of non-use values from other sites, and if they eventually could be used for the site in question.

Travel cost method could perhaps be used to valuate recreation and tourism

From the table it can among other things be seen that recreation and tourism could be services from both vegetation, wildlife and fish. These could be hard to separate when valuing damages and losses. The existence of wildlife depends on vegetation, mainly forests and similar cover, and the loss of vegetation might indirectly impact wildlife and thus the services it can provide. Thus, the valuation of these should be seen together if for instance using the travel cost method to value recreation and tourism as such. When valuing the benefits from recreation using the travel cost method, one should avoid "double valuation" if one also value loss of hunting, fishing, NTFPs etc. separately. Valuing hunting for subsistence through the value of the meat should yield an accurate estimate of the value for (local) hunters, although they might have a pleasure in the hunting itself that is not covered by this approach.

When some people are hunting for fun and recreation, not necessarily taking the meat value into consideration, the value of wildlife would be far higher than the meat value itself. This could be valuated using the travel cost method, trying to avoid "double valuation". See below how this could eventually be avoided. Alternatively, contingent valuation could be used. Since the recreation value is often connected to vegetation, wildlife and/or fishing, it is proposed to value the recreation value separately from all the species and services.

5.3 Vegetation loss could mostly be valuated from market prices

Vegetation could be defined as an assemblage of *plant* species and the *ground cover* they provide. It is a general term, without specific reference to particular species, life forms, structure, spatial extent, or any other specific botanical or geographic characteristics (Wikipedia.org). It is broader than the term flora which refers to species composition. Vegetation can, and often does, refer to a wider range of spatial scales than that term does, including scales as large as the global.

Starting with the direct and indirect use values, the various services that vegetation provide could be valued as follows:

Loss of fuelwood, timber and NTFPs could be valuated at market prices and lost net revenue

These services could be valued by estimating the gross revenues for each service (quantity multiplied by price), minus the costs of production. Prices of the products could be observed in (local) markets, eventually in published price lists etc., or special enquiries would have to be made to reveal the prices. In Brander et. al. (2016) there are examples of market prices on some NTFPs in Georgia like blackberries, blueberries, mushrooms and chestnuts. Production costs could be harder to estimate. The costs for timber production would be costs related to input for cutting and transporting the timber to a buyer, which could perhaps be found through contact to some timber companies or from previous studies. The costs of picking berries and similar would be low/negligible, and local market prices (if they exist) could be used. Eventually, national prices on the products could be used.

Thus, following the approach designed in Figure 4.2 the loss from market-based services from vegetation could be calculated.

Loss of carbon sequestration/storage could be valuated through various approaches

This could be valued in three alternative ways:

1. As the potential net revenue from selling additional stored carbon as carbon credits;
2. As the avoided climate change damages resulting from the storage of additional units of carbon in living biomass (mainly forests) and forest soil or
3. The costs of alternative actions to reduce emissions and/or increase sequestration to fulfil a national emissions target for greenhouse gases (GHGs).

Which one to use will depend on the situation in the country. If carbon credits from forest activities etc. could be sold internationally, the price (that could be achieved from international brokers, websites etc.) multiplied with the annual amount of carbon that could be stored minus the costs of setting up, monitoring, enforcing and marketing credits (which can be obtained from existing initiatives) could be used as an estimate of the value for the country. Alt. 2 is difficult, but there are some international studies that have estimated the global damages per ton of carbon emitted. Alt. 3 could be valued by observing or estimating the costs of alternative emissions reduction actions, given that Georgia has some national GHG commitments. The annual amounts of sequestration by each species could be found in (international) studies estimating this for various species and areas of the world. Similarly, the amount of already stored carbon that could be released if the vegetation was damaged could be estimated. Brander et.al. (2016) have some examples of how carbon sequestration could be valued in Georgia.

Loss of flood and landslide control could be valued by remediation costs, eventually based on previous damages or alternative actions

The services that vegetation provide to avoid floods and landslides could be valued using the avoided damages costs approach, i.e. the costs of a flood or landslide that could be avoided by vegetation. (Brander et.al., 2016). This involves assessing how the risks of damage events change with changes in forest/other vegetation cover, and then estimating the associated changes in expected damage costs. Physical damages would have to be assessed by some experts, eventually from comparing with historic events. The value of the damages could be estimated from the costs of historic events, i.e. costs of restoration of the damaged sites. Since landslides occur frequently in Georgia there should be several estimates of previous damages, but since each landslide is different and (all) historic costs could be hard to assess there will likely be some uncertainty in the estimates. Brander et.al. (2016) provides some examples of how landslide damages could be assessed and valued. An alternative valuation approach could be to value the costs of alternative actions to prevent landslides, if possible.

Loss of flora species (plants) could eventually be valued by removal costs or similar

Interventions may lead to partial or eventually total loss of species in an area. The value of this loss depends on how scarce the species in question are. For instance, if the plant is an endangered, red-listed species only situated in the area in question, the potential value of its loss might be huge. Then there would perhaps be some actions taken to preserve it, for instance by moving (some of) the specimen to another area if possible. In this case the actual costs of the avoidance/mitigation actions could be used as a (minimum) value of the existence of the species.

In cases where the species in danger of being lost in an area are plentiful, i.e. exist in lots of other areas in the country or elsewhere, the value of the loss itself will likely be small or nil, since the species would not be completely lost. Then the only potential value of the loss in the area would be the eventual loss of services caused by the local loss of the species.

5.4 Wildlife loss could be valuated from market prices and costs

Wildlife traditionally refers to undomesticated animal species, but has come to include all plants, fungi, and other organisms that grow or live wild in an area without being introduced by humans (Wikipedia.org).

Loss of meat can be valued by market prices

Hunting is an important activity in many areas, used by locals for leisure and/or to supply meat for the family or for selling in (local) markets. The loss of these services could be valued by multiplying the prices of the meat with the quantity lost, subtracting the hunting costs. The costs of hunting would likely be very low/negligible, related to gun use etc.

The availability of some wildlife species could attract hunters for recreational hunting or watching (for instance bird watching), which would yield additional losses to the loss of meat. These activities are valuated below.

Loss of species could eventually be valued by removal costs or similar

Interventions may lead to partial or eventually total loss of animal species in an area. The loss of animal species (fauna) could be valued in the same way as the loss of flora species, see above.

The value of this loss depends on how scarce the species in question are. For instance, if the species is an endangered, red-listed one that is only situated in the area in question, the potential value of its loss might be huge. Then there would probably be some actions taken to preserve it, for instance by moving (some of) the specimen to another area. Another action could be to alter the project/intervention to avoid it being lost. In both cases the actual costs of the avoidance/mitigation actions could be used as a (minimum) value of the existence of the species.

5.5 Fish loss could be valued from market prices

Fish is a part of wildlife, but could also comprise fish raised in fish farms. As for wildlife, the loss of fish catch can be valued by multiplying the prices of the fish with the quantity lost, subtracting the fishing costs. The costs of fishing would likely be low, related to boat use and fishing gear should be included.

The availability of some fish species could attract fishers for recreational fishing, which would yield additional losses to the loss of fish meat. How to valuate these activities are described below.

5.6 Recreation and tourism loss could be valued by loss of net revenue

Recreation and tourism often depend on vegetation wildlife, fishing, berry picking etc. In this context, the value of recreation could be the value of just enjoying nature, without taking into account the values of reduced catch of fish, meat etc. In some areas hunting of some animals, fishing etc. are activities that attract people from other parts of Georgia or even abroad, yielding a value to these people that they are willing to pay for. This value could by far exceed the value of the catch itself.

One way of potentially avoiding double valuation could be to valuate tourism activities in the area in question, given that the impacts are so large that they might impact tourism negatively. (Extensive tourism might also have negative impact on ecosystems, which according to TEEB (2013) have been observed in Georgia, but this is another issue).

The value of tourism and recreation in an area is the tourist's willingness-to-pay to travel to the area and spend time there, and reduced ecosystem services could lead to reduced number of visits and/or reduced length of a visit. One way of indirectly valuing this would be to assess the lost income from tourism in the areas potentially negatively impacted by the decrease in ecosystems or loss of species, and the reduced travel costs. This value could eventually be derived from Georgian public statistics, if this shows regional figures for the value created in this sector. If not, a simple, local survey could be carried out by contacting (local) companies in the tourist sector, to get some information on their revenue from the tourist sector, and some estimate of their potential loss. If getting information about where visitors come from, it could also be possible to estimate their travel costs. Thus, the total reduced willingness to pay to visit the area could be estimated.

5.7 Water damage could be valuated from abatement costs

Pollution of water can cause impacts on human health (through reduced drinking or irrigation water quality or by eating contaminated sea/freshwater food and plants irrigated with contaminated water), and harm animals, plants, shores etc. and thus have impact on leisure and tourist activities like fishing, bathing and also cause problems with odour (smell) and similar. How to value damages on animals, plants, leisure and tourist activities are described above. Below valuing of negative impacts on drinking and irrigation water quality and sea/freshwater food on human health is described.

Start with abatement costs

For valuing contaminated drinking or irrigation water there are two main approaches: 1) abatement costs, i.e. costs for cleaning contaminated water to achieve drinking or irrigation water quality, or supplying water from other sources, or 2) cost of illness and/or eventually premature death, given that the water has caused illness through contaminating the drinking water or sea/freshwater and plant food before or after actions to improve the quality have been carried out.

Often it would take some time before the water is cleaned, and it might not be possible to clean it to the required standard. Therefore, some actions to provide drinking and irrigation water from other, clean sources will likely be taken. Thus, the costs of these actions would represent an estimate of the value of reduced drinking water quality. These costs could be obtained from the local authorities in charge of drinking water supply, and/or the companies providing the alternative, clean water.

Odour etc. could only be valued by asking people through a survey what they would be willing to pay to get rid of it, or try and find some estimates from other studies that have valued this.

Cost of illness approach to value damage to human health

If the contaminated water is used and causes disease through drinking and/or eating sea/freshwater and plant food, the cost of illness approach could be applied to estimate the value of degraded water quality. Also, if the water is still used for irrigation purposes even if it has not reached the required standard, people could become ill from eating crops that have been contaminated from the use of low-quality irrigation water.

These costs could be estimated by observing costs of medical treatment, hospital admissions, loss of income etc., see chapter on Cost of Illness above.

5.8 Valuation of land damage

As for vegetation, wildlife, fish and water quality, the valuation of land damage should start by estimating the remediation costs to bring the damaged land back to baseline conditions. If there are still some damages left after the remediation actions, the impacts on human health should be assessed and valuated. Then the cost of illness could be estimated in the same way as for water quality loss described in chapter 5.7.

5.9 In practical valuation data availability and quality is often the most important factor for the valuation approach

The overview in the previous sections of this chapter shows that there are often not very many alternative approaches to choose among when valuating loss of ecosystem services. For many of the direct and indirect use values and values for optional future use the most obvious approach would be to calculate various remediation costs to bring the situation back to baseline. This should ideally be done for the site in question, but transfer of costs from other sites would be an option. The one should make sure that the costs transferred are covering the same situation/damage, and make necessary adjustments regarding income level, currency etc.

For remaining losses/damages or in the (perhaps unlikely) situation that remediation costs cannot be estimated, the often only viable approach is using market prices to calculate the various losses. This is often rather straight forward, and do not require any particular skill. Transfer of such data from other countries are often not an option, since the situation regarding demand/supply, substitutes, preferences etc. may be too different. However, transfer of prices between neighboring countries could be feasible if the conditions are similar.

The availability of data is most often the single issue that determines what approach to use, or if the good or service is possible to valuate at all. Time, costs and/or required expertise are often the main constraints for the collection of data beyond collecting simple observations of market prices etc. However, the latter can also be tricky when there are non-transparent markets, for instance for fuel wood. In such situations non-scientific approaches like talking to (some) people selling or buying fuel wood can provide the necessary information.

Because of lack of data, time, funding and/or expertise on often ends up with valuating only some of the damages on ecosystem services. The existence value is frequently the one lacking most due to these constraints. However, the best should not be the enemy of the good, and one should try and valuate as many goods and/or services as possible within the existing constraints, recognizing that this could be useful as long as one acknowledges that the estimated values underestimate the total value of the good or service. Then, a good description of the impacts on the remaining services that cannot be valuated would be a good alternative to valuation, and a supplement to the services being valued.

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Appendix 1: cases

In this appendix we present the following three cases as examples on how valuation of various damages could be approached:

1. Dam break, causing flooding and destroying forests, roads, vegetation etc.
2. Leakage of contaminated water into drinking water source
3. Leakage of contaminated water into a lake popular for fishing

None of these are real cases, but are constructed based on various incidents in Georgia and other countries.

A.1 Case 1. Dam break

The incident

A hydropower dam breaks down, causing masses of water to flow into the neighboring valley. On its way it destroys large areas of forest and other vegetation, and destroys roads. The valley is not very populated, but there are some damages to houses also. No people are injured or killed. The damaged area is used for timber production, and local people use the forest for fuelwood logging, berry and mushroom picking. There is also some hunting in the area. Also, there are several species of birds and mammals, and various species of flora, of those some endangered ones. Some of these have been damaged. Recently the valley has also become popular among international tourists for day visits.

Restoration

According to the requirements in the ELD the company responsible for the dam is asked by the authorities to restore the area back to the situation before the dam break. This restoration will consist of cleaning up of the area, i.e. removing broken trees, bringing the masses back onto the slopes etc. and planting new trees. The other vegetation is harder to restore, but nature itself will likely bring the vegetation back to its baseline position after some years. How many years this will take is uncertain. The damaged roads will be rebuilt, and the destroyed buildings will be rebuilt or compensated for in monetary terms.

The company estimate the total restoration costs. This is indirectly an estimate of (some of) the damages caused by the flooding. But there are also some losses that the restoration will not cover, mainly because it will take time to bring the area back to baseline conditions, and in the meantime there will be some losses. These remaining damages need to be assessed and valued. This could be complicated, since one does not know how many years the natural restoration will take.

Valuation of the remaining damages

It was assessed that the following damages could remain after the restoration:

Loss of forest/trees

The trees that was destroyed by the flooding could now or later have been logged and used as timber or fuel wood. Some of the broken trees could be used, but it is assumed that most of the trees that could have been used as timber are destroyed and cannot be used for any purpose. Furthermore, most of the trees that could have been used for fuelwood are destroyed.

Value of trees for timber production

An easy way to valuate the timber would be to estimate the value as the revenue (the number of lost trees * price) minus production costs as if all the trees had been chopped and sold today. But that would not necessary had happened if they had not been destroyed, since they would perhaps gradually have been cut down over time when each tree had reached the "right" (optimal) time for logging, yielding maximum value. It is challenging to estimate this future value since future timber prices are unknown and we do not know exactly when the trees would have been cut. Thus, there could be two alternative ways of approaching this:

1. *Estimate the value of the trees as if they all had been cut today*. This value is the gross revenue: price * number of lost trees – production costs. We know the number of trees lost, and can calculate the timber quantity from this with the help of some experts. How about the price? It could perhaps be observed in some statistics or similar, but most likely there is no easily available price. Then we have to ask around to find a suitable price. One could ask (local) forest owners and/or buyers about what price would be the right one to use, but could we rely on their answers? Their answers could be checked by national experts or people that know the timber markets. From this it should be possible to find a suitable price. Then there are the production costs. The relevant costs are the costs of cutting the trees and transporting the logs to the buyers. They are most likely even more unobservable than the price, and again we have to ask forest owners, (local) loggers, transporters or similar to get some indications of the costs.
2. *Estimate the future value of the trees.* In this approach we try and valuate the loss according to a more realistic baseline. Then we need an estimate for the future timber prices, which can be established from statistics of historic timber prices. If available, the statistics could be used to estimate annual future prices for the years when the trees are assumed to be cut. Furthermore, the future cutting pattern would also have to be estimated, based on for instance historic cutting patterns and/or knowledge of the age distribution of the various parts of the destroyed forest. One should also estimate future cutting/transportation costs. If the future price, logging pattern and cutting cost estimates could be established, one can calculate the net present value of the future cash flow using a suitable discount rate similar to the rate level used for investment projects in Georgia.

What approach to choose largely depends on the availability of the data needed, time, budget/costs and skills of the personnel. Alternative 2 could be the one closest to the actual baseline, but given

the challenge and uncertainty with this approach alternative 1 could be the most suitable approach to apply.

Value of lost fuel wood

Then there is the value of the lost fuel wood. One does not know exactly how much fuel wood that is lost, and how much of it that would actually have been used. Also, there is a question if households have alternative sources for fuel wood not too far away, and that would not have any alternative use (i.e. would not be used by others). Investigations show that there are no alternative fuel wood sources available nearby that could be used by the households. Therefore, the affected households would have to buy alternative fuel wood (or other fuels) in the market.

Then one needs an estimate of annual fuel wood use from the destroyed forest. This could be found through a (door-to door) survey among (a sample of) households. If this is too costly and/or take too much time, perhaps some representatives for (local) authorities, forest experts etc. could be asked for an estimate. Data from Brander et. al. (2016) shows the results of a household survey from Adjara, indicating that some 95 percent of nearby households cut wood, and very few buy wood at the market. The average quantity of wood used per year per household in this survey was 9.5 m^3, with a minimum use of 4 m^3 and a maximum of 15 m^3. All respondents use wood for heating, just over 80 percent use wood for cooking and 46 percent use wood for preparing animal fodder. These numbers could perhaps be used also in "our" area, if no better estimate is available. This is an example of a benefits transfer within a country, and one should try and check whether the numbers from Adjara would be representative for "our" case. The check would consist of whether the areas are of the same population density, income level etc.

When we have an estimate for the quantity of fuel wood used and the number of households affected, we need a price estimate for the fuel wood that would have to be bought in the market. If there is a well-developed local market for fuel wood, one could ask around for the market price. But one should also try and take into account that this new situation could increase the market significantly, implying that supplies would have to increase (perhaps from far away areas), thus perhaps increasing the cost and also the market price. If there is no or just a small local market for fuel wood, one has to imagine how a (temporary) fuel wood market, or a market for other heating/cooking fuels could be developed. There will be several years before new fuel wood has grown sufficiently so that households again can cut their own fuel wood. Forest experts and/or estimates of various fuel wood trees growth rates should give an answer to how many years the households would need to be supplied from other fuel sources. Then the present value of the costs should be calculated.

Should saved costs for time used for cutting fuel wood be subtracted? When people cannot cut fuel wood they will have extra time to do other things, for instance more paid work. This could be seen as a benefit that could be subtracted from the costs. When people engage in cutting fuel wood this is probably considered the best use of their time, otherwise they would have used it for other activities. What these are would vary between people: someone would take on more paid work (if possible), and others would use the time for various other non-paid activities. People might also have to spend some time getting the bought fuel wood and transporting it home. One could eventually try and estimate an average time saved, and value it with for instance half the average salary per hour in the area (assuming that half the time would be used for paid work). But all in all there is likely no great error made by leaving these costs out of the valuation.

Loss of berries and mushrooms picking opportunities

There is a lot of local people collecting blueberries, blackberries, mushrooms and chestnuts in the destroyed woods. This is mostly for subsistence, but some amounts are also believed to be sold both locally or to more far-away markets. These activities will no longer be possible until the vegetation is restored. Experts on vegetation should be able to estimate how long it will take before the vegetation is sufficiently restored so that these non-tree forest products (NTFPs) are possible to collect again.

Then there is the question of how large amounts of these products are collected annually, and what prices that should be used to calculate the loss. There is uncertainty as to how much of the NTFPs that were available, and how much of them that were actually collected. Since the collecting is done by local people, one should try and find out how many people in what local communities that have collected NTFPs) regularly, and how much. Again, one could ask local people or carry out a survey if there is time and money. Data from a survey in Adjara presented in Brander et.al (2016) indicate that 30 percent of households collect blueberries, 26 percent mushrooms, 16 percent blackberries and 7 percent chestnuts. There are also some (uncertain) estimates of amounts of collected NTFPs. The majority of households in this survey do not collect NTFPs. The survey also shows that people within av radius of 5 km are affected by reduced vegetation. These numbers could be used as a benefits transfer if no local estimates are easily available and/or it is not possible to carry out a survey.

Then prices of the products will have to be found, asking around for some information. If no such (reliable) local prices can be found, Brander et.al. (2016) present some market prices per kg from their Adjara survey. Prices for blackberries are in the range of GEL 5-10 per kg, blueberries GEL 7-10 per kg, mushrooms GEL 5-15 per kg, and chestnuts GEL 2-3 per kg. These can eventually be used if they are considered realistic for “our” case.

Now the loss of NTFPs can be calculated by calculating the annual loss for the future years when collecting NTFPs will not be possible, and then calculate the net present value of these losses. As for fuel wood, one could eventually subtract saved labor cost.

Loss of hunting opportunities

There has over the years been some hunting in the damaged area. This will in principle still be possible, but because of the open space due to lack of vegetation there will likely be few animals to hunt and little cover for the hunters. This will, however, gradually change in the coming years when the vegetation recovers. Besides, there are several other areas not very far away available for hunting. This is important both for locals hunting for subsistence and others coming from more far-away parts of Georgia to hunt

Therefore, it is assumed that there is no real loss of hunting opportunities to value.

Loss of species

Some flower species were destroyed in the flooding. One of these is an endangered, red-listed one, that exists no other place in Georgia. It is not sure that it will survive, but the restoration of the damaged area aims at ensuring this.

Thus, indirectly the restoration costs put a value on the specie in danger of being lost. However, the value of a species in danger of being lost could likely be far higher than these costs, since the willingness to pay to ensure further existence would likely be large. Georgia is a party to the Convention on Biological Diversity, and therefore has a responsibility to protect red-listed species on its territory.

Loss of recreation opportunities

Before the flooding the area was quite popular with locals for hiking and walking in the forest, watching birds as well as the flora etc. This will not be possible for several years until the vegetation recovers. The recreation opportunities will then gradually improve, and people will then likely gradually be coming back for hiking. There are some other areas with recreation opportunities, but they are about two hours of travel away.

This shows that there are some potential losses for local people that use this area (frequently) for recreation. This loss could be valued by the travel costs people take on to travel to the other area for recreation activities. However, this could be difficult to observe, requiring people stationed to eventually observe increased activities in the alternative area, eventually combined with asking people visiting this area if they come because their primary area is damaged. Alternatively, one could carry out a survey asking households close to the damaged area if they will travel to the alternative area for recreation activities.

None of these alternative approaches to the valuation are easy to apply. One has to try and assess how important this loss is, i.e. how many people that used the area, how large the travel costs are etc., and see if the loss seems large enough to justify the efforts of analyzing this further. If not substantial, this loss can remain un-valued. Another alternative is to try and find other studies that have valued this, and consider carefully if these values could be used.

Loss of tourism

Over the years there has been developed considerable tourist activities in the area. Local operators are receiving foreign tourists that are bussed into the area for hiking, animal-watching etc., and staying one night or two in local accommodation. This activity is now reduced considerably, resulting in fewer visits. However, there are several alternative areas in Georgia to visit, including the abovementioned area some two hours away. Thus, tourists face a limited/no loss, and Georgia as such also face no loss since the number of tourists visiting the country will likely not be affected.

But for the local area and operators there will be a loss for some years until the area recovers. It is also a danger that the loss might be permanent if tourists are not coming back. Is this a loss that should be valued? Generally, when environmental damages are valued, it is the value for the *country* that is relevant. There may be lots of various actors that may loose from the environmental deterioration, and some might gain as this example shows. Usually, these gains and losses are considered as “transfers”, and not valuated. However, who gains and who loses are often described (and eventually valuated in monetary term) to get a picture of losses and gains. And if there are no alternative sites to visit there would certainly be a loss that should be valued.

The local loss from reduced tourist activities could eventually be valued by calculating the net loss from these activities, i.e. the lost income – saved costs. Since these are often internal numbers of relatively few companies, it may be hard to get reliable data for the loss. Eventually, numbers from similar incidents other places in Georgia or abroad could give an indication of the loss.

Loss of landslide protection

The damage of the vegetation could increase the chances for landslides that could damage a larger area than the one we are considering. But since the area is being recovered, it will after some years again contribute to landslide protection. However, there will be some years when the landslide protection is reduced until the area is fully recovered. To valuate this, one need the probability of a landslide to occur and some cost estimates of the damages. The probability of a landslide can be developed from statistics showing the frequency of landslides in the area or in other, similar areas, and some overview of historical damage costs. For the latter, data on average compensation payments is useful. Brander et.al. (2016) shows how the avoided damage costs from landslides could be calculated, and has some data (including historical compensation costs) that could perhaps be used.

Then the total, estimated costs of a landslide could be multiplied with the probability for the landslide to occur.

Loss of carbon storage

Trees and vegetation take up (sequester) carbon when they grow and store it as long as they stay alive, and contribute to take carbon away from the atmosphere in an effort to limit global warming. When trees and vegetation are destroyed there will be a release of carbon into the atmosphere, contributing to global warming. Georgia has signed the Paris Agreement, which aims to keep …"global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius". Thus, the country might want to reduce its emission of greenhouse gases and increase the uptake of carbon to contribute to this goal. A way to value the carbon loss from the damaged area could be through the costs of implementing alternative actions to reduce emissions or increase the uptake of carbon, if the country has an active policy on this issue.

There is a market for selling carbon credits to other countries, international companies or other interested buyers through an agreement where the country commits itself to implement actions to reduce emissions and/or increase uptake of carbon. There is no agreement on carbon uptake connected to the damaged area, so there is no loss from reduced credit sales revenue. Since such agreements should ensure actions that would not take place in the absence of the agreement (one should not be paid to do things one would do anyway), it is not likely that the restoration of the damaged area could be connected to a new agreement on the sales of credits from this area. This restoration will take place anyway as part of the liabilities in the ELD, and would therefore not be eligible for new agreements on carbon credit sales.

A.2 Case 2. Leakage of contaminated water into a drinking water source

The incident

Due to a pipe leakage huge amounts of toxic water from a factory spills into a lake used as a drinking water source. It takes some time before the leakage is discovered, and when it is the lake is so contaminated that it is no longer possible to use it as a drinking water source. Therefore, the authorities issue a ban on the use, but some people already got ill from drinking the water before the ban was issued. They need medicines and also some hospital treatment.

Restoration

According to the requirements in the ELD the utility responsible for the leakage is asked to restore the lake back to its initial condition. The flow of toxic water into the lake is quickly stopped after the leakage is revealed, and the pipes are sealed and changed.

It is soon realized that cleaning the whole lake is not possible. Cleaning the amounts of water used for drinking purposes could be possible, but likely very costly. The utility starts the work to find out this. Restoration could also happen through natural recovery, and data from similar incidents show that this could take many years. In the mean time other source of drinking water supply will have to be found if the water from the lake could not be cleaned at acceptable costs.

The valuation of a lost drinking water source

The costs of alternative sources

Someone suggests that the fee paid for the drinking water supply could be a way to value the water, since this is what people actually pay for it. But it is soon revealed that the fee does not cover the utility's historical cost of supplying the water. Besides, the costs of alternative supply are likely even higher than the historical costs. There are several alternative ways of supplying water:

- *Buy bottles and cans in the local store*. This is possible for small amounts and as a short-term alternative supply, but is no suitable solution in the longer term. Eventually, the price of the bottles/cans is an indication of the value of the drinking water.
- *Alternative short time supply*. As an emergency solution drinking water is supplied by trucks that stops in various streets in the affected villages, allowing people to come and collect water (for free). The costs of this is a part of the value of the lost drinking water.
- *Organize some other long-term alternative supply*. Since it is assumed that a (natural) recovery of the lake will take many years, one starts to look for more permanent supply alternatives. A new pipeline could be built from a lake more far away from the contami-

nated lake, and the costs for the construction is investigated. Another alternative could be to use ground water, and the costs of establishing and running this alternative (if possible) is also investigated.

It is after some time revealed that the costs of building a cleaning facility for the existing, contaminated water source will be higher than establishing alternative sources, and it is also uncertain if it is possible to have it sufficiently cleaned to be suitable for drinking. Also, the alternative with building a new pipeline is estimated to be too costly to pursue. The ground water alternative however, seems promising, given that sufficient amounts of ground water can be found. Thus, one decides to pursue this alternative as a long-term solution. In the mean time water will have to be supplied by trucks in the street.

The total value of the lost drinking water

Then the total value of the lost drinking water consists of the following parts:

- *The costs of temporary water supply*. This is the costs related to supply by trucks in the village. The costs for people having to collect water from the trucks instead of being supplied through the tap should also be estimated, if significant. This could be done by estimating an average time spent by a household per day collecting water, and then multiply this with total affected households. Then this number could be multiplied with a price, that could be the average hourly wage rate in the area reduced with a share accounting for that not all household members are working (for instance using half the wage rate).
- *The medical costs*. These are the costs for medicines and hospital treatment for those who got ill from drinking the contaminated water. These costs could be found from local doctors and hospital that have treated people, assuming that all of them had to seek medical help.
- *Other costs related to illness*. These are costs related to lost income from not being able to work, and the disadvantages and discomfort of being ill. These costs could be hard to find, and one might perhaps carry out a survey going around asking some people in the village that have been ill what their costs have been. If one then knows the total number of ill people from doctors and the hospital, one can calculate the total costs/loss from the illness. The disadvantages and discomfort from being ill will likely not be valuated, implying that the presented value will underestimate the actual costs of illness. Eventually, the costs of discomfort could be found from other studies that have estimated it.
- *The costs of establishing and running the new, permanent supply source*. The total investment and operating costs of supplying ground water should be included. But the (saved) operating and maintenance costs for the old supply source should be subtracted, so that only the cost increase is included (given that the costs for the new source is higher).

A.3 Case 3. Leakage of contaminated water into a lake popular for fishing

The incident

The utility that operates the sewer network in the town has a failure in one of its pumping stations, causing untreated sewage to flow into the lake. This again causes the oxygen level in the lake to fall, which together with the ammonia in the sewer has a toxic effect on the fish population. And since it took some time before the cause of the damage was found, thousands of fish are killed. This has a devastating effect on the fishing activities. There are both some commercial fishing activities, and some local people fish for leisure/subsistence. There are also some people travelling from other parts of Georgia to fish in this fish-rich lake. The incident causes bad smell (odour) in the nearby village, and since it happens in the summer it also has some negative impacts on bathing and other leisure activities in and around the lake.

Restoration

According to the requirements in the ELD the utility responsible for the leakage is asked to restore the lake back to its initial condition. The flow of raw sewage into the lake is stopped after the pump breakdown is discovered. But besides some cleaning up along the lake shores, there is little the utility can do to restore the lake. The restoration will therefore have to happen through natural recovery over time. It is hard to say how long this will take, but based on experiences from other similar incidents it is assumed that it might take some years. In the mean time the fishing potential will likely be gradually improved.

The valuation of the damages

Thus, the value of the contamination of the lake will have to be decided by estimating the value of the various damages and eventually some actions to reduce these. The following damages have occurred:

- *Reduced commercial fishing*. The fishermen report that there is less catch, and problems selling the fish in the local markets since consumers assume that the quality is reduced and the fish sometimes smells. The utility carries out a small survey among the few affected fishermen to ask how much they have lost since the sewage release happened, and what their expectations are for future losses. Their loss is both related to reduced catch and reduced price for (some of) the catch, due to reduced quality. Their costs related to the fishing activities (vessel fuel. crew etc.) is also asked for. From this information the net total loss could be calculated, based on reported loss already occurred and expected, annual future loss, subtracting the saved costs. A difficult part here is to assess how long time it will take before the catch will gradually come back to normal. Different calculations using various number of years until full recovery are made to illustrate this uncertainty. The future net loss is discounted to its present value, using a suitable discount rate.

- *Reduced local leisure/subsistence fishing*. There is no statistics or overview of how many locals that fish for subsistence/leisure. Therefore, the utility carry out a survey by asking some (selected), local households if they fish in the lake, how much they usually fish and what their loss have been so far. Then they must estimate how large the total catch loss have been, and calculate the direct loss from reduced catch, using the market prices for the fish that the professional fishermen have reported. No costs should be subtracted, since it could be assumed that the costs they take on with the fishing activities are something they are willing to pay to do the activities. These costs can therefore be seen as a (partial) value for the leisure part of the activities, and thus the gross calculated loss will also cover part of the lost leisure activity from reduced fishing. Estimated, future losses must be discounted to its present value.
- *Reduced fishing/leisure activities for people from other parts of Georgia.* As for local fishing/leisure activities there is no statistics/overview of this. But people that travel from other parts of Georgia often stay overnight, and reduced number of stays can give an indication of the reduced activities. The utility therefore ask the local inns etc. about what their (estimated) net loss from reduced fishing opportunities might be. However, this will underestimate the loss, since the total value of this fish and leisure activities is likely higher. What they pay for this at the local inns will only be a part of the value, some people would for instance be willing to pay more for it. Estimated travel costs (if possible to get) could also be included, but the value would still be a low estimate. The number of affected people will also be underestimated, since there are some people that travel to and from the lake the same day. Perhaps there are other ways of finding how many people are affected, for instance through reduced purchase of local fish permits, (if needed). If the total number of affected people is found, one could perhaps find some values for similar activities from other parts of Georgia or other countries (benefits transfer), but the use of these should be considered with great care.
- *Reduced bathing and other leisure activities*. In the same year as the leakage the possibilities for bathing and other leisure activities are severely reduced because the water is considered unhealthy, and there is an unpleasant odour coming from it. The nearest alternative lake for bathing/leisure is one hour travel away, and could represent an alternative for some people. How many people that are affected is uncertain, but some rough estimate are possible to obtain by asking some locals about it. The only realistic way to find the value of this is to carry out a contingent valuation survey, i.e. ask a representative number of people what they would be willing to pay to have the lake back to normal conditions. Such a study would also indirectly value most of the other local losses, so if carried out one should take this into account to avoid double-counting. Alternatively, one could try and find some estimates for this from other parts of Georgia or abroad (benefits transfer), but such estimates should be considered with great care among other things to avoid double counting.
- *Odour from the lake*. People living around the lake experience some smell from the lake, especially on hot days. This disadvantage could only be valued by asking people through a survey what they would be willing to pay to get rid of it (see above). Alternatively, one could try and find some estimates from studies in other parts of Georgia or other countries. However, such benefit transfer should be considered with great care.

Appendix 2: some useful web-sites

Below are some useful technical websites for support on valuation of ecosystem services and biodiversity.

Biodiversityeconomics.org

Ecosystemvaluation.org

Envirovaluation.org

Evri.ca

Beijer.kva.se/valuebase.htm

Vista Analyse AS
Meltzersgate 4
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www.vista-analyse.no