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Ecosystem disservices and externalities

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Ecosystem disservices and externalities

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I. Introduction

The first objective of this discussion paper is to provide the national accounting community with an understanding of the concept of externalities as the term is used in the economics literature and as it is applied in discussions of economic policy by different regulatory authorities. Externalities, or external effects as they are also called, can have both positive and negative effects on wellbeing for members of society[2]. While examples of both kinds of effects are discussed the focus is on negative effects as set out in the terms of reference for the paper.

Once the term is defined and its use in policy laid out, the second aim is to examine how, and in what ways, negative external effects could appear in the SEEA EEA, both in the Supply and Use tables as well as in the asset accounts. To date, under longstanding accounting principles and conventions, all externalities (not only environmental) have been excluded from the core of national and corporate accounting. The behavioral responses to externalities (e.g. buying bottled water when the public source is polluted), however, are reflected in the accounts through the economic transactions people make. Given the conventional position, it would not be straightforward to change this situation, even with sound arguments. Nevertheless, it is an essential part of this exercise to present such arguments where they are relevant.

The paper is set out as follows. Section II provides a definition of the term of externality, with a range of examples of both positive and negative cases. The literature is complicated by the fact that the term is used in a range of contexts, which have different policy connotations. These are laid out to familiarize the reader with the different ways in which externalities are sub-categorized. The discussion is relevant for policy relevance of externalities, which is then laid out, in particular answering the question whether the presence of an external effect merits action on the part of the regulatory authorities and if so in what form?

A key practical application of externalities for policy is predicated on having an estimate of the magnitude of their size, usually measured in monetary terms. Section III discusses how external effects have been valued, how accurate such values are and how useful they have been in determining policy. Negative externalities affect both the flow of services from particular ecosystems, by reducing the wellbeing that members of society can derive from them, and possibly

[1] The lead author is first and foremost to be considered as the penholder of this paper, which builds upon the massive work, including extensive discussions, within the SEEA community, especially the people directly involved in the revision of SEEA Experimental Ecosystem Accounting. This revised draft has taken into account several comments from Bram Edens, Salman Hussain, Joe St. Lawrence and Carl Obst. The lead author is grateful to them in helping make the paper clearer.

[2] Wellbeing is measured in this context in terms of individual willingness to pay for a good or service or willingness to accept payment for its loss. The link between wellbeing and national accounts is discussed in DP5.1. A key result is that variations in wellbeing can reasonably well be approximated by variations in Net Domestic Product (NDP) (Weitzman, 1976) if externalities and other distortions are not present. The terms wellbeing and welfare are widely used interchangeably in the literature.

also the stock value of such systems, by reducing the flow of services and wellbeing they can provide in the future. The literature on valuing both kinds of impacts is discussed.

While the mainstream literature on valuing externalities focuses on monetary valuation, based on anthropocentric value systems, and the idea of externalities is basically an economic concept, the presence of such externalities also affects other measures of the value of Ecosystem Services (ESS) (see DP5.1). A brief discussion here of how these measures relate to externalities is presented.

Section IV explores the linkages between negative externalities and flow and asset accounts in the SEEA EEA. These are made though the effect of such externalities on the value of ecosystem services (ESS), many of which are included in the SEEA EEA. The scope for specifying external effects explicitly in these accounts is discussed. Where ESS are not in the system boundary including them involves modifying the boundary of the accounts, or creating intermediate service provision categories or both. The discussion is given a practical context and made concrete by considering specific examples of what are normally considered as negative externalities. The discussion covers both the flow accounts as well as the asset accounts.

Section V concludes the paper and offers some suggestions on how the discussion in this paper can contribute to steps in incorporating negative externalities in the SEEA EEA framework.

II. Externalities and External Effects: Definitions and Policy Relevance

Definition of an externality

A number of definitions of externalities exist in the literature. All have in common the feature that they refer to actions by producers, consumers or communities on others in society that are not fully taken into account by the perpetrators of the actions[3]. Some definitions focus on the role of markets; for example, the OECD defines externalities as "situations when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided" (Khemani and Shapiro, 1993). Others do not specifically set the definition in a market context and define externalities as impacts that "arise when the actions of an individual, firm or community affects the welfare of other individuals, firms or communities [and the] agent responsible for the action does not take fully account of the effect" (Markandya et al, 2001). In this second case, however, markets where agents receive payments for their actions or have to make payments, could represent situations where the welfare effects are fully accounted for in the transactions and no externality is present.

A number of features of the definition need further elaboration. The first is that externalities in the economic literature require **some agent** (individual, household, enterprise or community body) to be responsible for the action that has an impact on the wellbeing of others. This means that natural phenomena that generate positive (or negative) effects on welfare without any human involvement are not externalities[4]. We return to this point later.

[3] The actions are generated in pursuit of production or consumption of goods. In this sense they are deliberate but not in the sense of being undertaken with the intention of causing harm or providing a benefit.

[4] It should be noted that human involvement through, for example, forest and land management practices can have implications on the natural phenomena and make them either more or less severe (e.g. wildfires and forest management).

The second is the need to better understand what is meant by fully taking account of the effect of an action. This is best seen in relation to an example where an upstream firm is polluting the water that causes residents downstream to receive water they cannot use without further treatment, which entails a cost. The amount of pollutant emitted per period is shown on the horizontal axis in Figure 1. On the vertical axis there are two curves. The MB curve represents the marginal benefit in monetary terms to the polluter of releasing the waste into the water. The MD curve is the marginal damage (also in monetary terms) caused to the downstream residents per physical unit of pollutant. If the upstream firm has no obligation to limit its releases it will continue to the point where they are equal to OQ_M. At this point further releases have zero benefit to the firm. If it were to reduce releases, it would face a cost for each unit, which is small initially but rises as the quantity removed increases – hence the downward sloping shape. The costs to downstream residents, however, increase with emissions so each additional unit has a higher cost than the unit before. Hence the MD curve slopes upwards. In the absence of any controls on the upstream firm emissions will be, as stated equal to OQ_M. At this point the marginal cost to the upstream firm of a small reduction in emissions is much smaller than the benefit to the downstream residents in terms of reductions in damages (the former is shaded red and the latter is the red and green shaded areas). From this it is possible to see that to take account of the emissions impacts on welfare, so that net gains are maximized, the emissions should be reduced to OQ_*. In this sense an externality will exist as long as emissions are not at that level. If, however, the emissions are reduced to OQ_* the externality has been **internalized** and its associated impacts are now a matter for other social considerations [5]. Emissions at the level OQ_* are also referred to as efficient or ´Pareto Optimum´.

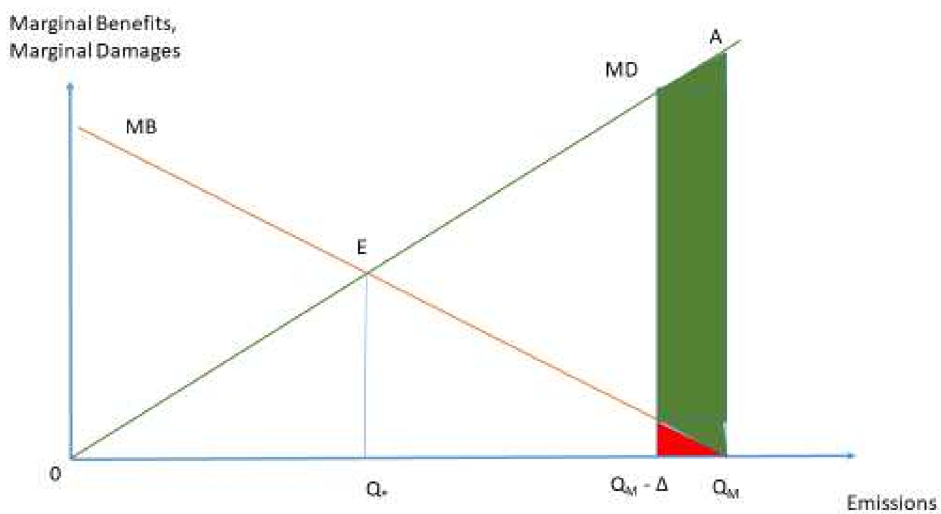

Figure 1: Emissions and Externalities

The third feature of externalities is to recognize that the use of the term externality has been extended to cover more than just the actions of agents where markets are involved. For example,

[5] To obtain the Pareto optimum it is enough to reduce emissions to OQ*. It is not necessary to compensate the pollutee or tax the polluter; that is a decision to be made on equity grounds, possibly through the allocation of property rights.

externalities of childbearing are referred to as the costs or benefits of bearing and raising children that do not fully accrue to the parents, but instead are passed on to society, and which are not mediated by economic markets. If there were no externalities of this sort, then optimal individual fertility decisions would lead to socially optimal fertility, and there would be little role for government policy in reproductive decision-making (Lee, 2001). In a fiscal context, Chetty and Finkelstein (2013) refer to externalities on government budgets when the government itself provides multiple types of social insurance or levies taxes. For instance, expansions in disability insurance may reduce the probability that a worker with a high disutility of work chooses to search for a job and claim unemployment insurance. A more general source of fiscal externalities is taxation. Any reduction in labor supply induced by social insurance programs will have a negative fiscal externality on the government by reducing income tax revenue.

For the purposes of this discussion paper, we limit ourselves to externalities of the kind where ecosystem services are affected by the actions of agents and do not consider externalities in the wider sense described above.

Lastly we note that the definition of the externality given here is an anthropocentric one and does not easily relate to other value systems in the ecological literature. As DP5.1 correctly notes, there are many such value systems. Values in psychology relate to emotions and principles and goals which guide human behaviour; in philosophy values relating to the living environment are seen as endowing the latter with certain inalienable legal rights, which mean that the living environment has value in and of itself, separate and independent from the benefits humans may derive from it for their own purposes (sometimes referred to as intrinsic values). Ecological value refers to the "perceived importance of an ecosystem, which is underpinned by the biotic and/ or abiotic components and processes that characterise that ecosystem." (Barton et al, p. 16). Anthropologists make a distinction between the social value of a transaction and the market value, noting that the former may be much more important than the latter. Externalities, as defined in the economic context are not an appropriate concept in this context. Anthropologists would see them as representing a core part of the system of transactions rather than something that is outside the system and needs to be ´corrected´.

Similarly, there are other concepts of value that would not see what economists call externalities as needing ´correction´, at least not in all cases. Moreover, they may seek to define the desirable level of use of an ecosystem differently from the way characterized in Figure 1. The use of the term externality as elaborated in this paper does not seek to deny these other approaches but notes that its use as a tool of policy is mainly framed in economic terms and it is this definition that forms the basis of the discussion in this paper.

Implications of the economic definition of externality

There are some further implications of the definition of an externality that are important for its application in an accounting framework. The first is that an externality is not equivalent to the presence of pollution or of something that reduces the performance of ecosystems. In Figure 1 the externality would be fully accounted for in wellbeing terms if emissions were reduced to OQ_*. At that point, however, emissions will still be equal to that amount and not zero. Thus in determining what pollution effects to include in any accounting framework this distinction needs to be addressed. This distinction between the presence of an externality and the presence of emissions is often missed in the popular discussion of the topic[6].

The second is that the ´optimum` level of pollution can be brought about through a number of channels. One would be an agreement between the upstream polluter and the downstream community, where the latter would offer the former a compensation equal to the cost of reducing emission to OQ_* from OQ_M (equal to the area EQ_*Q_M). This would still leave the community better off than with no deal (by the amount equal to the area EAQ_M). This would depend on a number of factors but critical among them is the allocation of property rights to the water body. If the rights are with the upstream firm the downstream community would compensate it to the extent mentioned. If, however, the rights are with the downstream community then the firm would have to buy rights equal to OQ_* for an amount equal to at least the area OEQ_*. If such negotiations are possible and carried out the problem of the externality is solved by private negotiation, something pointed out many years ago (Coase, 1960). This is an important factor in deciding which externalities to include in any accounting exercise and which ones to leave out, on the grounds that they have been internalized by private negotiation. To be sure, not all externalities lend themselves to internalization through private negotiation. The reason why we may still have an issue with externalities is that for many pollutants property rights are not well defined and negotiation between parties when dealing with public ´bads´ is not always possible.

Another way to bring about the optimum would be to impose a tax equal to EQ_* for each unit of pollution by the upstream firm. If the firm is a profit maximizer it would then reduce emissions to OQ_*. A third would be to offer a subsidy for every unit pollution reduced from level Q_M, which would also reduce emissions to OQ_*. Finally, if we were dealing with emissions from a number of polluters and the rights to pollute equal to Q_* were supplied for sale the market in permits would also result in the optimal level of emissions[7]. Indeed, a market economy in which inputs and outputs are sold and bought at prices set by competitive conditions ensures that any negative impacts of production and consumption is kept at a level where it is no longer an externality. If such internalization has taken place the question of how the externality should be represented in an accounting framework could be different from a situation where it has not been internalized. A decision needs to be taken as to whether impacts of any residual pollution from an externality that is optimally controlled should be included and how the costs of that optimal control should be recorded. This issue is discussed further in Section IV.

Ecosystem Disservices

Ecosystem disservices is a category distinct from externalities, where the cause is an action by a human agency. With ecosystem disservices the cause is a natural phenomenon that has a negative

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[6] It is possible of course that the optimal solution would be one with zero emissions. This would be the case, for example, if emissions are highly toxic, or if a negotiation between parties determined that a zero level is a Pareto efficient allocation (i.e. a point from which neither party can gain without the other losing). Such solutions are also referred to as corner solutions and, apart from the highly toxic case, are more likely in negotiations between small groups (e.g. neighbors´ agreements on periods when loud music cannot be played).

[7] The transactions involved in each case, however, are different. In the case of a tax, the polluter makes a payment to the government, which can use it as part its general revenue to allocate it for specific purposes (earmark it). With a subsidy the polluter receives a payment while in the case of permits the flows depend on how they are allocated. If they are auctioned the payments are from the polluter to the government, while if they are allocated based on current emissions, there is a transfer to some polluters, who may also face some costs as allocations will usually be less than current emissions. Tracking these in the national accounts raises a number of questions. See discussion in Section IV.

impact on human wellbeing. Examples include wildfires, the presence of different disease vectors such as malaria and wild animals that damage crops. In these cases, action to control the effects is justified and the nature and extent of such action can be determined by comparing its costs against the benefits generated[8]. Conceptually, however, and from an accounting perspective, such disservices and associated actions are different from externalities[9].

Examples of externalities

Externalities can be both positive and negative. In the example in Figure 1 it was negative because it imposed a cost to the third party but there are also cases where the actions of one agent can create benefits for others. The following examples include both and also include cases where the definition of an externality as given in section I does not apply. Nevertheless, such cases have been referred to as externalities in the literature and need to be considered further.

Emissions of local air pollutants from transport and electricity generation

A negative externality is created by agents (vehicle owners or power generators) that reduces the wellbeing of individuals within the country and even in other countries by creating emissions that reduce air quality. Although there are a number of restrictions on such emissions, aiming to achieve a shift to an efficient level, most communities would take the view that levels are not that level and a relevant externality is present.

Plastics deposited in rivers, lakes and oceans

There is a negative externality here, created by the action of the agents depositing the waste in these bodies. It damages the functioning of the ecosystems that receive them, thus reducing the wellbeing of those that depend on such ecosystems by reducing ecosystem service flows. Given the very limited control on such deposits the level of externality would be considered as policy relevant.

Beekeeping

An example of a positive externality. Beekeepers produce honey but also provide pollination services of considerable value to other farmers. Some of these services are not paid for but some are (in the US alone commercial pollination services generated USD650 million in 2012)[10]. Overall, however there are many places where negotiation between agents to ensure an optimum level of beekeeping cannot be assumed. Hence here we have an ecosystem service that is not fully accounted for in market transactions is present.

Carbon sequestration from soil and forests

Forests and soils provide a positive externality to the extent that they sequester carbon from the atmosphere, which, if it remained there, would have an impact on the climate globally. There are now some payment schemes for sequestration through REDD+ programs but they are tiny compared to the extent of the sequestration that takes place and the externality is clearly relevant for policy. On the other hand, removing forests without compensating replanting could release carbon into the

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[8] Some disservices are at least in part induced by human actions (e.g. the likelihood of fires). This makes the distinction difficult to draw in practice and some cases may better be treated in the category of externalities while others are better seen as disservices.

[9] Note that if you are unable to identify the agency responsible this is not the same as assuming there is no agency. In such cases there is still an externality.

[10] https://www.ers.usda.gov/webdocs/publications/37059/49131_special-article-september_-pollinator-service-market-4-.pdf?v=0

atmosphere and creates a negative externality. The same applies to land use practices that reduce the amount of carbon stored in the soil.

Deforestation and loss of other ESS

Apart from sequestration, forests provide a number of ESS that are not all transacted through markets, such as sources of medicines, non-timber products and species biodiversity. The values of some of these services may appear in the national accounts but not all of them. Where they are included, their loss could be an externality and the aim would be to account for that negative externality flow. When the forests are cut down, losses affect welfare and are relevant for policy purposes. Hence there is a case for including them as relevant externalities.

Resistance to antibiotics

Excessive and improper use of antibiotics is a case where the user of the antibiotic does not take account of the effect the use has on making the drug less effective for other users in the future. This is a classic case of a negative externality and clearly one that has not been regulated to the point where it is no longer relevant for policy.

Avian influenza

Avian influenza refers to the disease caused by infection with avian (bird) influenza (flu) Type A viruses. These viruses occur naturally among wild aquatic birds worldwide and can infect domestic poultry and other bird and animal species. Avian flu viruses do not normally infect humans. However, sporadic human infections with avian flu viruses have occurred. In this case the negative impact is not the result of any human agency and while its control would involve expenditures by public and even private agents it does not constitute an externality as it is not the result of actions of any individual, production unit or public body. It is an example of an ecosystem disservice.

Losses of ESS through forest fires

Some fires are natural phenomena and as such do not constitute an externality. Others where they are the result of careless actions, however, would count as such. Regulations to control such behavior are widespread and can be quite punitive, but most communities would take the view that the frequency of fires resulting from human negligence are more common than is acceptable and the external costs they impose merit consideration as externalities.

Removal of vegetation or open spaces in urban areas

Open spaces in urban areas used for recreation constitute a public good and its removal or extension are best treated as changes in the supply of such goods, as discussed in WP5.1. The open spaces and vegetation that is within them also provides ESS in the form of improving air quality and reducing the heat island effect during periods of high temperature. The loss of these services when such vegetation is removed may constitute an externality that is not normally taken into account when making decisions relating to removal of such vegetation[11].

These examples point to a number of factors that need to addressed in including externalities in an accounting context. The focus will be on negative externalities as set out in the TORs for the DP.

i. Is the negative impact an externality in the sense defined in Section I?
ii. If it is, has the externality internalized through private negotiation or through effective public regulation?
iii. Can a link be established between a given ESS and the activity generating the externality?

[11] Note that not all removal of vegetation is a negative externality. Some studies showed a higher WTP for managed rural habitats as opposed to say climax vegetation.

iv. Given such a link, can the impact be measured in monetary terms, and with what level of accuracy?

v. How would such impacts be included in any Supply and Use tables and in asset accounts as determined by the SEEA EEA?

Answers to question (iii) through (v) are addressed in the next section.

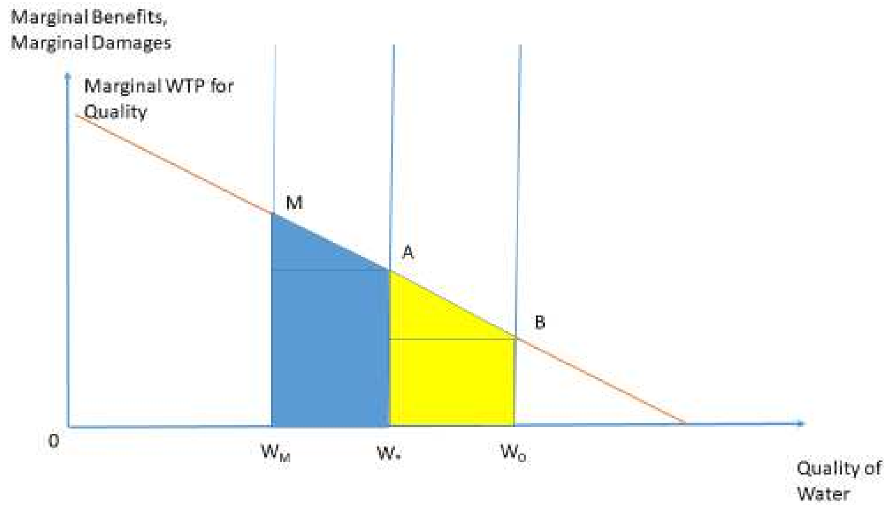
III. Measuring Externalities in Monetary Terms

There is a substantial literature on the costs of environmental degradation from various sources measured in money terms (Sarraf et al., 2004; Fredua, 2014). The World Bank in particular has been active in estimating the costs for a number of developing countries. In Europe estimates of such costs have been made by Markandya and Tamborra (2006). For estimates of the global cost of degradation see Costanza et al. (2014) and for land degradation see Nkonya et al. (2016).

These studies and others of a similar nature provide estimates of the total costs to different agents as a result of a degradation of the environment relative to a baseline that can best be described as one without any anthropogenic pollution**. As has been noted in Section II, however, this is not necessarily the same as the monetary measure of relevant externality for policy purposes**. If pollution had been controlled optimally, the ´degradation´ as measured in these studies would also be the optimal amount and the cost to society would need to be measured relative to that optimal level of degradation. Corresponding to Figure 1, which analyzes the emissions and their costs and benefits, Figure 2 looks at the corresponding services provided by the ecosystem. In the case of the constructed example, the services are clean water with specific chemical parameters delivered to downstream users[12]. With no pollution the quality of such water available would be $0W_0$. When the upstream firm pollutes the water the quality declines to OW_M (corresponding to emissions OQ_M in Figure 1). If an optimal solution is negotiated the quality delivered is OW_* (corresponding to OQ_* in Figure 1).

Figure 2: Values of Water Quality Degradation Measured in Degradation Studies

[12] For simplicity it is assumed that the quantity of water is not affected by the upstream operations but the quality is.



The question then is what would the studies that estimate the cost of pollution measure? If there are no controls, the costs to downstream users would be the losses represented by the yellow and blue areas as W_0 is the quality with no emissions and W_M is the quality with the maximum emissions. If, however, a negotiated solution is in place the costs are given by the yellow area only. As quality is now W_*.

In practice it is very difficult to determine whether or not the actual controls for the externality are optimal. The best that can be done is to measure the additional costs arising from the externality without knowing for certain whether it is the yellow area or both the yellow and blue areas. This means measuring the costs relative to an environmental quality that would exist in the absence of human activity. This is what studies of the costs of environmental degradation have done. To clarify the basis of the estimation it might be desirable to report the value of services that would have been available if the externality had not been present. This would be recorded as supplementary information as this flow did not actually happen and therefore would not be included in the accounts.

Note further that the measured amounts here are equal to the full consumer/producer surplus loss to the users of water. This includes the exchange value (the rectangular part of the yellow and blue areas[13]) plus the triangle, which represent what would be the surplus if there was a price for the water quality that had to be paid. It is possible in most cases to obtain only the area under the rectangles; this is discussed further below.

Methods used to estimate the losses due to the externalities vary across sectors. Table 1 summarizes some recent studies and methods used to estimate the losses. Details of different methods of valuing ESS have been discussed in some depth in WP5.1 and are not repeated here. The same methods are also applied to estimate potential or actual losses when ESS are impaired due to negative externalities.

Table 1: Methods Used to Estimate Costs of Externalities in Different Sectors

[13] Exchange values are discussed extensively in DP5.1

Source of Externality	Study (*)	Impacts Covered	Methods Used
Emissions of PM	World Bank-IHME (2016)	Premature deaths	Estimation of WTP to reduce risk of death in OECD countries, converted to a value of statistical life (VSL), with values transferred to developing countries
Water contamination	Prüss-Ustün et al, (2008).	DALYS	Epidemiological data to estimate loss of DALYS due to water pollution by country, valued using a link between a DALY and VSL proposed by the World Bank (Cropper and Khanna, 2014)
Land degradation	Sutton et al (2016)	Loss of productivity	Comparison of actual net primary productivity of land against its potential productivity by ecological zone for all countries
Materials use	OECD (2019), UNEP(2019)	Damage to ESS	Damages to ESS from extraction, use and disposal of materials. Potential damage ranges estimated by author.
GHG Emissions	UNEP (2018) US Gov. (2013)	Impacts on climate and associated damages	Damages from climate change draw on losses to agriculture, industry, energy and other economic sectors as well as effects on human health and life. A range of methods value the different effects
Deforestation	Markandya & Chiabai (2013)	Loss of timber, non-timber, recreational and passive values	Market data for timber and non-timber losses. WTP studies for recreation and passive value losses
Marine Ecosystems	Costanza et al., (2014)	Losses due to lower flows of a range of ESS over time	The method is based on 'benefit transfer', where studies for a few sites for a given biome were used to obtain estimates of values of ESS per hectare. These were then transferred to other sites with the same biome. The ESS values for oceans was gas regulation, nutrient cycling, biological control, food production and cultural services. For coastal areas services included disturbance regulation nutrient cycling, biological control, habitat refuge, food production, raw material, recreation and cultural services

Sources: See table. The cited sources draw on other studies that are not included.

Key features of these estimates of losses relevant to inclusion in an accounting framework are the following:

i. Not all estimates identify the source of the damage to ESS. With air and water pollution the sources are different additions to the air and water, which can be measured in physical terms, but in the cases of land degradation, deforestation or marine pollution the source are not given; only the change in the value of services over time is measured. With materials use the source is clear, although work on estimating its impact on a range of ESS is limited.

ii. In no case are the agents causing the externality explicitly identified in the studies. This may simply be because the studies are not focusing on that aspect and in some cases the parties responsible can easily be identified. This is the case with air and water pollution, with material use and GHG emissions. It is less easy to do so with land degradation, deforestation and marine ecosystems but in principle it should be possible to associate the negative externality with a particular source.

iii. The measurement of degradation does not address the question of whether the measured effect is relevant for policy or not. In other words, has the impact already been adjusted to obtain an efficient solution as explained in Section II? Measurement is made relative to a ´zero anthropogenic impact´ point. For example, with $PM_{2.5}$ emissions natural concentrations are taken to be 10µg/M^3 and any concentrations above that are evaluated in terms of their effects on human health, ecosystems etc. With water pollution natural levels are considered to have zero contaminants. With land degradation the natural condition is taken as that of potential productivity with no human impacts (with the caveat that some managed systems have higher value than completely unmanaged ones). This means that the policy relevance of the external costs needs to be assessed separately and it does not follow that all externalities should be eliminated.

iv. The methods of valuation used are an eclectic mixture. WTP based and hedonic methods are used for air and water pollution. In the case of land degradation estimates are based on market exchange-based values. GHG emissions are valued from a mix of exchange-based and WTP methods, as are forest losses and marine ecosystem, degradation. In an extensive review of methods used to value ESS, de Groot et al (2012) provide a breakdown of methods across different kinds of services. These are reproduced as Table 2. The actual breakdown for losses may not be the exactly same but is likely to be very similar. Cost based or market based methods dominate the provisioning and regulating services, while stated and revealed preference methods play a greater part for habitat and cultural services. Broadly speaking the market values and cost based ones would be close to exchange values while the other two would involve full WTP estimation.

Table 2: Methods Used to Value Ecosystem Services (%)

Ecosystem Services	Direct Market Values	Cost Based Methods	Revealed Preference	Stated Preference
Provisioning	84%	8%	0%	3%
Regulating	18%	66%	0%	5%
Habitat	32%	6%	0%	47%
Cultural	39%	0%	19%	36%

Note: Percentages sum across the rows.
Source: Adapted from De Groot et al., 2012

IV. Incorporating Externalities and Disservices in Accounting Systems

Externalities and disservices are not directly recorded in the SNA or SEEA CF as there are no corresponding transactions (although, as noted earlier, the impacts of externalities make themselves present in various transactions where individuals take actions to avoid the negative impacts) nother important element is that transactions are undertaken by mutual agreement of the actors involved. The 2008 SNA says (para 3.53).[14]

[14] The definition of a transaction stipulates that an interaction between institutional units be by mutual agreement. When a transaction is undertaken by mutual agreement, the prior knowledge and consent of the institutional units is implied. This does not mean, however, that both units necessarily enter a transaction voluntarily, because some transactions are imposed

Given the transaction based nature of the accounts, as well as the focus on actual exchanges (rather than exchanges in case of perfect markets) the SNA does not recognize externalities (Barton et al., 2019). By expanding the production boundary, the SEEA EEA recognizes a form of positive externalities - ecosystem services - which arguably would satisfy the mutual consent criteria. A contentious issue is whether the SEEA EEA should also be able to reflect negative externalities pertaining to the environment.

When it comes to ecosystem disservices the authors of DP 5.1 note:

"Some ecosystem disservices are already reflected in economic output. For instance, when a farmer is sick due to malaria, he works reduced hours and as a result has lower yield and hence revenue. It would in theory be possible to make such externalities visible by introducing a disservice transaction (e.g. in the form of negative ecosystem output) which would be intermediately consumed by (in this case) the agriculture sector, raising its value added. In the income distribution accounts the additional income could be returned to the ecosystem. Although a notion of negative outputs feels pretty awkward for national accountants, something along these lines was proposed in the SEEA 1993."

In this section we follow up on this suggestion, looking at a number of cases that treat externalities and disservices differently. Treatment of these effects in the SNA will vary according to the nature of the externality. The following cases are looked at:

i. A negative externality that has an impact in the same period as it occurs
ii. A negative externality that has an impact on an ecosystem asset, with impacts over several periods in the future
iii. An ecosystem disservice with impacts in the same period as it occurs
iv. An ecosystem disservice with impacts on an ecosystem asset, with impacts over several periods in the future.

In cases (ii) and (iv) treatment of the effects as a form of degradation is probably more appropriate but the question is up for discussion. There may be other sub-categories, but these seem to be the main ones. **It should be noted that all examples are intended to describe events that have actually happened rather than possible alternative scenarios or prospective situations.**

A negative externality that has an impact predominantly in the same period as it occurs

Assume we have a stylized economy that consist of the following economic sectors:

- Sector A (say a farmer) produces product X (crops) valued at 200
- Sector B (say a water supply company), produces product Y (clean water) valued at 300
- Sector C (an engineering company), which produces product Z (filtration services) valued at 20

Assume the ecosystem provides a water supply service as an input into producing Y.

by force of law, such as payments of taxes or other compulsory transfers. Although individual institutional units are not free to fix the amounts of taxes they pay, there is nevertheless collective recognition and acceptance by the community of the obligation to pay taxes. Thus, payments of taxes are considered transactions despite being compulsory. This kind of transaction, sometimes called a "something for nothing" transaction, or a transaction without a quid pro quo, is called a transfer in the SNA.

Regarding the externality, assume sector A emits agricultural liquid wastes, which enter into rivers and water bodies, causing costs to downstream users of the water bodies, in this case sector B. As a result of the externality, we assume that the water supply service of 50 (that existed in the absence of the externality) has been reduced to 30. At the same time, due to the externality, the ecosystem provides a second ESS, a waste disposal service, to A, which we assume to be valued at 25. The 25 can be thought of the cost of disposing the waste in an alternative way and not using the river.

Sector C can be thought of as providing a filtration service to sector B, by removing the effect of the externality on B, but that is not essential for the calculations. The effects are within the current accounting boundaries so GDP is not affected but the representation of the external effects helps to identify where the costs arise and who could be required to pay for them (although that is a policy matter).

As shown in the upper part of Table 3, in the present SNA accounts these externalities and ESS that do not have a transaction are not included. GVA from sector A that produces X is 200 and GVA from sector B that produces Y is 250. Sector A provides 30 worth of intermediate inputs to sector B. Sector C produces Z to the value of 20 intermediately consumed by sector B. Total GDP of our hypothetical economy is therefore 470.

The lower part of Table 3 shows a possible recording that includes both ESS and the externality, specifically:

- 25 worth of ESS to A (the disposal service) and a negative externality of -20 (as ISIC A causes the externality) thus giving a VA for A of sector of 155 instead of 200.
- 30 worth of ESS to B, which also bears the cost of the externality. This can be thought of as the value of the raw water that B uses to provide potable water as the final product. The 20 worth of externalities that A creates are borne by B, resulting in a VA from B of 240 instead of 250. If there had been no externality, the value of the raw water would have been 50 and not 30.
- The ´ecosystem´ as a sector provides a net VA of 55, i.e. 25 to A, 30 to B.

Table 3: Introducing ESS and Externalities into the SNA - Case I

Current SNA	Ecosystem	ISIC A	ISIC B	ISIC C	H´Holds	TOTAL
Supply						
Ecosystem						
Externality						
Output X		200				200
Output Y			300			300
Output Z				20		20
Use						
Ecosystem						
Output X			30		170	200
Output Y					300	300
Output Z			20			20
Value Addded		200	250	20		470
Transfer						
Disposal Income		200	250	20		470

With Externality	Ecosystem	ISIC A	ISIC B	ISIC C	H´Holds	TOTAL
Supply						
Ecosystem	55					55
Externality		-20				-20
Output X		200				200
Output Y			300			300
Output Z				20		20
Use						
Ecosystem		25	30			55
Externality			-20			-20
Output X			30		170	200
Output Y					300	200
Output Z			20			
Value Added	55	155	240	20		470
Transfer	-55	45	10	0		0
Disposal Income	0	200	250	20		470

The result is GDP of 470 as before but the system recognizes the lower VAs of A and B, as well as B´s being impacted by the externality created by A. We note the following points in the example:

- The ecosystem service value in the absence of the externality is 50 but this is not observed as such. What is measured is the service of the ecosystem to A (25) and to B (30).
- The externality is measured here as the amount by which the value of the raw water to B is reduced by the activities of A (i.e. 20). This can be measured.

There will be objections on including negative values for transactions, which have been discussed previously. The advantage of including them is that the services provided by the ESS are explicitly recognized, as are the externalities imposed by the use of the ecosystem by one party. The amounts represent monetary values, which raises questions of valuation discussed in the previous section and whether they are exchange values or not. It should also be noted that the figures do not address the question of whether it is optimal to remove all the effects of the pollution. In this example the impact of the externality on B (of 20) is neutralized by the purchase by B of filtration services from sector C (also of 20). The amounts need not be equal in which case some residual externality would remain and need to be valued, possibly as a cost to households, which is not in the accounts. As a result, GDP may decline.

The method also requires acceptance of the ecosystems as an agency that is affected by economic activities. It has been argued forcefully that, since the ecosystem cannot receive compensation and cannot act to maximize its wellbeing it has no agency. The way round that would be to see the ecosystem as represented by an agency responsible for its regulation, acting as a custodian on behalf of society. One would then see the value of the loss as the cost of negating the impact of the externality, as would be done for other damages to public services. This avoids the problems of valuing the losses using the market-based or other methods discussed in the previous section but has the disadvantage of not allowing the accounts to be used to evaluate the option of negating the externality through different measures.

Externalities that could be treated in this way include: emissions to rivers and lakes, emissions to coastal waters, air pollution in the form of PM, ozone, NOx. Estimates of external costs from these sources are available in the literature, although there is an issue of exchange values for some of the components (especially for air pollution and recreational losses from water pollution).

A negative externality that has an impact over several periods

In many cases the externality will not only result in damages in the present period but will also cause damages in future periods. Emissions of GHGs would fall into this category, as would soil erosion from deforestation, silting of reservoirs from deforestation and costs arising from material extraction, use and disposal. In such cases the activity resulting in the externality damages the ecosystem, which is an asset, although it is not always included in the asset accounts. If it is included, the degradation of the asset could be recorded in the asset accounts and Net Domestic Product (NDP) would be lower with the accounting. Table 4 includes a recording of the value of the ecosystem as an asset on the assumptions that: (a) services of 55 are provided from the asset in perpetuity[15] and (b) the discount rate is 4%. A negative externality of 20 occurs in year 1, reducing the value of the services provided by the ecosystem in that year but has an impact in future years at a declining rate. The rate of decline is assumed be 20% per annum over the coming years. The results are:

(a) A decline in the ecosystem service in year 2, from 55 to 35.
(b) A decline in the asset value for the ecosystem from 1,375 at the start of the period to 1,278 at the end of the period and a NDP that is 373 compared to a gross GDP of 470.
(c) Value added in each sector is less by 22.7% (sector A) and 3.7% (sector B) than without the ecosystem account, reflecting the amount by which that ecosystem asset is responsible for a use flow.

[15] Implicit in applying such a valuation over a long period is the assumption that that the preferences of future (in some cases yet-to-be-born) consumers can be assumed to be equivalent to today's consumers.

In this case it is probably best to record the externality as the cost of the degradation to the ecosystem – i.e. 97. This can be shown as a separate row below the Gross Disposal Income to obtain the Net Disposable Income.

While this may work in principle, the calculations will not be straightforward in practice. A value for the ecosystem will need to be established if an asset account is to be available. For some ecosystems, attempts have been made in wealth accounts but not for all. For example, the atmosphere as a source of clean air is not valued as an asset; nor is the atmosphere as a basis for a stable climate. In these cases, the degradation of the asset can still be valued but not the asset itself.

The background DP5.4 (Obst et al., 2019) raises a number of problems that need to be addressed when measuring degradation of ecosystems and most of these will need to be considered in measuring the degradation. The aim is to estimate the change in the present value of all services provided by the ecosystem. Issues that arise include:

- Losses in value due to unexpected events are not included in the degradation of the asset
- Losses or changes in value due to changes in prices, reflecting changes in future demand ae also not normally included
- If the degradation takes the form of a change in ecosystem type (e.g. a forest is converted to cropland. In this case it is the loss in value after allowing for the change in type that is of interest but the suggestion is made that this kind of conversion merits separate accounting entries (loss of ecosystem A as one entry and creation of ecosystem B as another).

As the authors note, degradation is a wider concept than depletion. Depletion constitutes a subset of degradation, since it refers only to the capital cost associated with provisioning services from an ecosystem, in cases where the provisioning services are being generated unsustainably. Degradation encompasses capital costs associated with provisioning and other ecosystem services.

Table 4: Introducing ESS and Externalities into the SNA - Case II

Current SNA	Ecosystem	ISIC A	ISIC B	H´Holds	TOTAL
Supply					
Ecosystem					
Externality					
Output X		200			200
Output Y			300		300
Use					
Ecosystem					
Output X			30	170	200
Output Y				300	300
Value Addded		200	270		470
Transfer					
Disposal Income		200	270		470
Net Disposal Income					470

With Externality	Ecosystem	ISIC A	ISIC B	H´Holds	TOTAL
Supply					
Ecosystem	55				55
Externality		-20			-20
Output X		200			
Output Y			300		300
Use					
Ecosystem		25	30		55
Externality			-20		-20
Output X			30	170	200
Output Y				300	300
Value Addded	55	155	260		470
Transfer	-35	25	-10		-20
Gross Disposal Income	0	200	270		470
Degradation	97				97
Net Disposal Income					373
Ecosystem Asset Value T=0	1375				
Ecosystem Asset Value T=1	1278				

An ecosystem disservice with impacts in the same period as it occurs

The case of a disservice, where no agent is responsible is illustrated in Table 5, based on an example from Bram Edens. As in the other examples the SUT for the economy has two products X and Y and ecosystem service A. Now a disservice B is introduced – the suggestion in the example is of elephants trampling agricultural produce and thus reducing output. The upper table shows normal SNA recordings, which would not recognize ESS. The lower table recognizes both the ESS and the disservice. After transfers the same disposable income results but this recording both the service and disservice have been made visible.

Table 5: Introducing ESS and Disservices into the SNA - Case III

Standard SNA	Ecosystem	ISIC A	ISIC B	Household	Total
Supply					
Ecosystem Service A					0
Ecosystem Disservice					0
Product X		200			200
Product Y			80		80
Use					
Ecosystem Service A	0				
Ecosystem Disservice	0				
Product X			25	175	200
Product Y				80	80
Value Added (Supply-Use)		200	55		255
Transfer					
Disposable Income	0	200	55	0	255

Adjusted SNA	Ecosystem	ISIC A	ISIC B	Household	Total
Supply					
Ecosystem Service A	70				70
Ecosystem Disservice	-20				-20
Product X		200			200
Product Y			80		80
Use					
Ecosystem Service A		70			70
Ecosystem Disservice	0		-20		-20
Product X			25	175	200
Product Y				80	80
Value Added (Supply-Use)	50	130	75		255
Transfer	-50	70	-20		0
Disposable Income	0	200	55	0	255

Negative Externalities with Effects not Captured in the SNA Boundary

A number of important negative externalities relate to impacts on wellbeing are not in the SNA boundary. Perhaps the most important of these is GHG emissions, generated from the combustion of fossil fuels or burning of wood from forests, but there are also emissions of local pollutants such as SOx, PM, NOx etc. that also fall into this category. In the cases of GHGs the concentration in the atmosphere increases, affecting the climate and hence the wellbeing of all citizens in the world, present and future. Simply logging of timber where the wood is used, say, for construction, does not create emissions and hence does not change concentrations of GHGs. This aspect of logging is not an externality (although it does create other externalities).

In terms of SNA accounts one can easily identify the agent responsible for the emissions, but the affected parties are less easy to place. It is not only households in the country but also households in other countries. One way of representing the affected parties may be to have the government as a proxy for these, on the grounds that it is responsible through international agreements for addressing the emissions. This does not always work, however, given several cases where governments do not respect the terms of such agreements.

Representing the externality, however, is more difficult. It could conceivably be done by considering the emissions as a degradation cost and charging it to the value added of the polluter (see Table 6). This would have the effect of reducing net value added of the economic activity (and hence of our economy) by the amount of the emissions (in this example, they are 5).

The method is not satisfactory, however, for two reasons. One is that the degradation should be of an asset but the asset is not defined, or at least not recorded in monetary terms. The second is that the accounts do not show the reduction in wellbeing of any agent by the externality.

Table 6: Introducing GHG Emissions as an Externality into the SNA - Case IV

Standard SNA	ISIC A	Household	Total
Supply			
Product X	200		200
Use			
Product X		200	200
Value Added (Gross)	200		200

Adjusted SNA	ISIC A	Household	Total
Supply			
Product X	200		200
Use			
Product X			200
Value Added (Gross)	200	200	200
Degradation	5		5
Value Added (Net)	195		195

The earlier examples of externalities were linked to an ecosystem, which provided a known value of services and the externality caused a decline in the value of these services. One possibility would be to record the decline as an environmental liability (as we do not have an asset to charge this against) – as was also mentioned in DP5.3 on accounting treatments (section 5), for instance by introducing so-called unpaid ecological costs, leading to negative savings. This would be a potential solution for global commons such as climate (or beyond EEZ fish stocks). A second would be to ignore the value of services provided by the atmosphere as an ecosystem but look only at the deterioration in its value resulting from the externality. The loss of services from this externality, however, is almost entirely in the future. Moreover, it can be global; in the case of GHG emissions, for example only a small share of the effects of emissions in any country will be felt in the country generating the externality. There is little to record as a loss of wellbeing in the current period and most of the loss in the future will be outside the territory of the country concerned. The social cost of carbon (SCC) attempts to estimate the discounted present value of the loss in services from the atmosphere when there is a small increase in emissions but no attempts have been made to value the baseline of services against which the losses are measured. Yet, SCC is used in evaluating mitigation projects that reduce emissions and in determining the global pathway to be followed to optimize the social benefits of future development[16]. In both these cases, the use of extended SNA accounts with externalities are not likely to be of much value.

V. Conclusions and Next Steps

This paper has laid out the concept of externalities as it is used in economic theory and policy and also discussed the concept of economic disservices, making a clear distinction between the two. Externalities require actions by economic agents that affect the wellbeing of other agents but are not fully taken into account by the perpetrators. Disservices are phenomena that do not have any agent responsible for them. Both actions can have a positive or a negative effect but negative ones are more common.

An important factor to consider when looking at an impact as an externality is whether it has been internalized, with private negotiation or through regulation. Different forms of regulation are possible and most negative externalities in modern societies will have some regulation, although it is unlikely to be enough to attain full internalization (i.e. a Pareto Efficient Outcome).

Where action is needed, estimates of the costs of externalities are required. Estimates have been made of such costs in a number of areas, including air and water pollution, land degradation, deforestation, use of raw materials and damages marine ecosystems. The agents responsible for the actions are not always clearly identified in the studies. Nor is the asset being affected by the externality always valued. There are also gaps in the estimation, the figures have considerable uncertainty bounds and methods of valuation are a mixture of those that are compatible with exchange values and those that are not. The latter represent cases where full WTP/WTA estimates have been made. It should be possible to replace these with exchange values in some cases, or to use costs of replacement in others (as would be done when valuing public goods) but this needs further investigation.

If externalities or disservices are to be included in extended SNA accounts this requires acceptance of ecosystems (or someone acting on their behalf) as an agency that is affected by economic activities. Possible accounting treatments that show externalities in extended accounts have been presented. It may be possible to see ecosystems as part of the public sector and to value the externality loss as the cost of negating the impact of the externality. This needs further discussion. The problem is more severe when dealing with externalities that impact not only the current flow of ESS but also future flows. In the second case, we also have degradation of the asset to take into account and methods for measuring degradation have to be used, bearing in mind issues that arise in such measurement.

A few of examples have been presented of how externalities might be recorded in Supply and Use Tables and in asset accounts. They do not by any means, however, cover all possible cases and more work is needed to analyze the problems that arise in other cases, especially where the externalities affect households and where payments are specifically made by agents to the government because of the externality, or where compensation is paid to those suffering a negative externality. It should also be noted that there are several externalities (e.g. my playing music irritating my neighbors) that are outside of scope of SEEA EEA (and the SNA). The scope here is about externalities that originate from or impact on ecosystems.

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[16] In mitigation project assessment the SCC can be replaced by the costs avoided from a reduction in emissions in one country as proposed in the SEEA. Another alternative is not to use the SCC at all but to conduct a cost effectiveness analysis, with the least cost projects that meet a given reduction being the ones accepted.

The most problematic case is where the externalities relate to ESS that are not in the SNA boundary and that involve ecosystems whose asset values have not been determined. This is especially so with GHGs, which are a global externality (i.e. the impact of a ton of GHGs is global). The paper argues that it is probably too complex to try and include these in an SNA accounting system. One suggestion is that we agree first on how to treat externalities in “simpler” cases in terms of understanding how they are embodied in various transactions and changes in stock (including ESS and ecosystem assets): If that can be done successfully, then the GHG emissions answer might fall out. Another is to have a separate set of accounts for such a global externality that supplements the national SNA accounts.

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