Publications

Tittle : **Function Evaluation as a Framework for the Integration of Social and Environmental Impact Assessment**
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Abstract

Social Impact Assessment (SIA) and Environmental Impact Assessment (EIA) have developed as separate entities. But a full appreciation of all impacts requires a thorough understanding of all the biophysical and social changes invoked as a result of a planned intervention. Because of second and higher order effects, biophysical impacts also have social impacts, and social changes can cause changes in the biophysical environment, which create biophysical impacts. To date, there has not been an adequate framework for integrating biophysical and social impact assessment. This paper presents a method for biophysical and social integration using function evaluation as a conceptual framework. The framework has led to a better understanding of the full extent of human impacts, as well as the impact pathways that lead from interventions to the experience of impacts.

Introduction

There is a growing concern about the environmental and social consequences of development efforts. The developed world potentially faces enormous costs due to the need to restore and to protect the environment in order to safeguard natural resources for future generations. Developing countries must consider how their social and economic development can be combined with protection of the environment and preservation of their natural resources, not as a luxury, but as a necessity for sustainable development.

When applied in the earliest stages of the decision-making process, Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) can become important project planning instruments. They provide information on the consequences of specific development activities in a way that these consequences can be taken into account and used in the process leading to a final decision and in designing mitigation measures. Proper application of EIA and SIA can significantly improve the quality of project proposals and will eventually lead to important savings on project implementation because of reduced negative impacts and better acceptance of the project objectives.

Since the publication of the Brundtland Report (WCED, 1987) and the UNCED conference, or Earth Summit, in Rio de Janeiro in 1992, the concept of sustainable development has gained wide acceptance and the idea that environment and development are strongly interrelated is recognised by many. Further, poverty and gender assessments are likely to become widely used instruments of planning in development cooperation. Since EIA is the most developed instrument, backed by a legal framework in many countries, it is increasingly used to also assess the social and economic impacts of planned interventions. The obvious consequence of the desire to integrate environmental, social and economic aspects of project assessment is the apparent need for an integrating framework. So far, the worlds of environmental impact assessment, *sensu stricto*, social impact assessment, and economic cost-benefit analysis have operated in their separate realms.

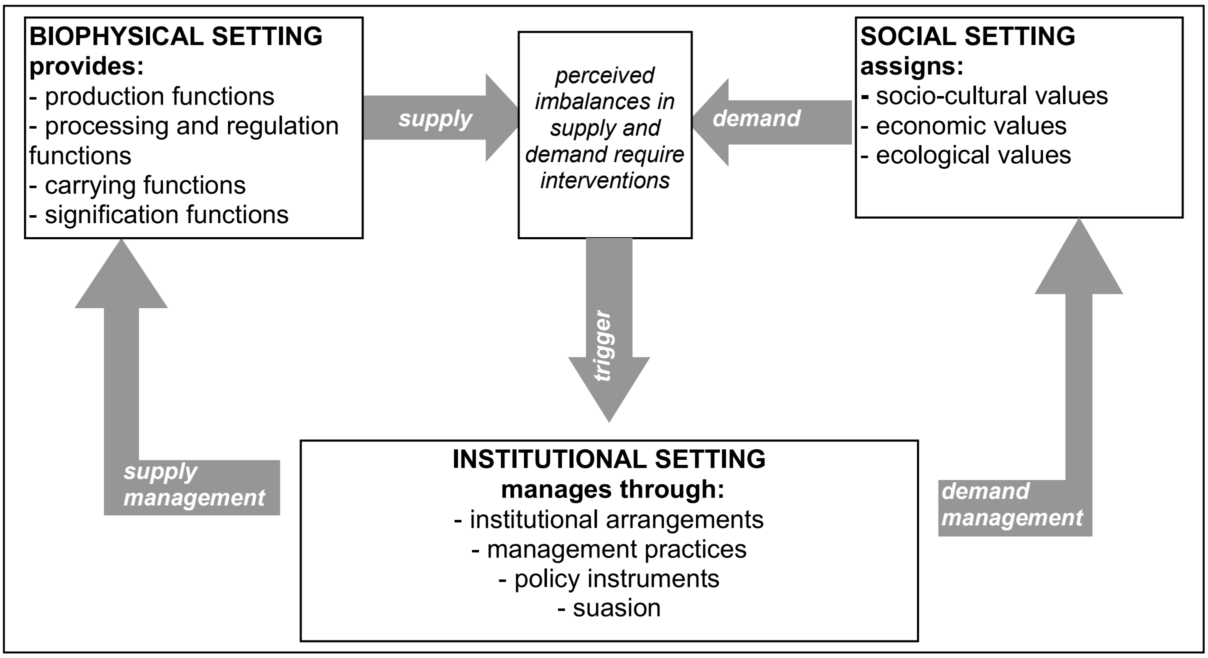
In this paper, an attempt is made to construct a conceptual framework that provides a harmonised and integrated way of thinking and which will assist in the identification of potential environmental, social and economic impacts of a planned intervention. The framework is designed to have broad application, and it provides insight in, and understanding of, the complex cause-effect chains that may lead to desired or undesired effects. It is partially based on an approach that translates nature and natural resources into functions for human society, often referred to as *function evaluation*

(R.S. de Groot, 1992). This concept bears some similarity to the discussion of environmental goods and services that exists in some countries. We realise that the terminology used in this discussion can easily lead to misunderstandings, since some erms may have a different meaning in other contexts. To assist, we provide a glossary of the terms we use in a specific way in Appendix 1.

Figure 1: main settings in function evaluation
Concept developed further from an original idea conceived in conjunction with Rob Koudstaal in a study for the Wetland Group Foundation: Wise use of wetlands: a methodology for the assessment of functions and values of wetlands. (Unpublished document).

either the supply from nature or the demand from society. Institutions can, in this sense, be national, regional or local authorities with their formal instruments and regulations, or they can be traditional chieftains or village elders with their traditional techniques and customary laws. In a globalised world, international agencies that exert effective control over human activities could also be included, for example, potentially the Framework Convention on Climate Change, the Biodiversity Convention, or the Montreal Protocol on Substances that Deplete the Ozone Layer.

As shown in Figure 1, three main settings can be identified:



- The natural environment (or *biophysical setting*) comprises a combination of living and non-living resources and their interactions. Resources perform functions in providing goods and services which are used by each society.
- Human society (or the *social setting*) encompasses all human activities, knowledge, beliefs and values. As a result of human activities and social values (which are influenced by societal knowledge and beliefs, i.e. culture), environmental goods and services (that is the functions of the biophysical environment) are valued in a social context. These environmental values can be expressed in economic, socio-cultural (including spiritual) or ecological terms. These values, to a large extent, depend on the societal context, differing between cultures, and they also differ for different groups within a society.
- The *institutional setting* consists of the institutional arrangements (authorities, legal

The settings

The conceptual framework presented here aims to provide insight into the relations between human society and the biophysical environment. The focus of this conceptualisation is the characterisation and classification of the functions provided by the biophysical environment and the assessment of their value for supporting human activities. The framework is based on the so-called function evaluation of nature. Leading authors in this field are, among others, R.S. de Groot (1992) and W.T. de Groot (1992). The starting point in this approach is that society utilises products and services that are provided by the biophysical environment. In economic terms, society constitutes the demand side, and the environment constitutes the supply side (see Figure 1). Simply stated, sustainability deals with the equilibrium in supply and demand, now and in the future! Perceived imbalances in this equilibrium trigger institutions to act by managing framework, traditional laws and regulations), management practices (such as physical structures e.g. dykes, roads, etc.), policy instruments (permits, subsidies, quota, etc.), and the use of suasion by governments or agencies in an attempt to change people's beliefs or behaviour.

Figure 1 depicts how the need for action is triggered by a perceived inequilibrium in the relation between supply and demand. The demand for goods and services from nature may surpass the available supply, which leads to a present or expected future **problem** (e.g. over-exploitation or insufficient supply). The opposite may also occur; some of the functions of the natural environment are not exploited and to the extent that they are recognised, this represents a development **opportunity**. Both problems and opportunities may trigger an initiative from the policy or decision-makers, who through their institutional arrangements, policy instruments, management practices and suasion, will try to solve the problem or benefit from the development opportunity. This intervention either works via the side of the biophysical setting by managing the supply of environmental goods and services (provision of agriculture, forestry, hydraulic engineering, etc.), or via the side of the social setting by managing the demand for goods and services (through tax incentives, setting of quota, trade negotiations, etc.).

The biophysical setting

The natural system comprises many environmental functions that provide goods and services that can be utilised by human society. Whether all of these functions are actually utilised is dependent on the social, economic and cultural 'behaviour' of the society concerned, its state of development and technical knowledge, etc. Of course, it is not necessary that all of the identified functions of an ecosystem are used, and furthermore, ecosystems may possess functions that are not as yet identified – one of the primary arguments in support of biodiversity protection. Combining the clear but somewhat simplified classification of Rudolf de Groot (1992) and the theoretically more appropriate classification of Wouter de Groot (1992), four categories of environmental functions can be distinguished:

(1) Production functions refer to the ability of the natural environment to generate useful products for humanity. A distinction is made between natural production functions and nature-based human production functions. **Natural production functions** include products that the natural environment largely produces on its own, that is without human input other than humans being harvesters (hunting and gathering). Products can be produced over a short term (e.g. firewood, fruit, streamwater, ocean fisheries) or they are produced over a long time period (e.g. oil, minerals, fossil groundwater). The first category are often referred to as renewable resources, while the latter are considered non-renewable. The logging of old-growth forests for lumber or pulp would be renewable if undertaken on a sustainable yield basis, or would be arguably non-renewable if done by clear-felling operations with little or no regeneration of native forests. **Nature-based human production functions** refer to the production of biological (animal or plant) products by the biophysical environment in ways that involve active management and inputs by people. Examples here include most agricultural and horticultural activities, forestry plantations and managed forests, and fish ponds (aquaculture and mariculture).

(2) Processing and regulation functions (or maintenance functions) relate to the maintenance of ecosystem support systems. The interactions between biotic and abiotic components result in complex processes that influence the conditions for maintenance of life support systems. These functions are often not recognised until they are disturbed. They refer to the ability of ecosystems to maintain or restore dynamic equilibria within the system, or in other linked ecosystems through physical, biological and chemical processes and interactions. Processing functions often undo the harm caused by human activities or reduce the risk to humans. Such functions include the sequestration of carbon dioxide, the dilution of pollutants, and the active chemical transformation of harmful substances such as organic waste. Examples of regulation functions include: maintenance of groundwater levels, maintenance of biological diversity, protection against natural forces (coastal protection by mangroves) and protection against harmful cosmic radiation (ozone shield). Water storage in wetlands is an example of a regulation function for river flow regulation.

(3) Carrying functions are related to space or a substrate that is suitable for certain activities and for which there may be a demand. The availability of space together with a particular set of environmental conditions associated with that space make an area more or less suitable to perform certain functions for humans. Examples include suitability of an area for human habitation and settlement, nature conservation areas, areas for nature-based recreation (e.g. mountain climbing, bushwalking, skiing, beach tourism), waterways for navigation, and sites for energy conversion (e.g. hydropower reservoirs).

(4) Signification functions refer to the social values that are ascribed to nature itself (natural heritage values) and to other features of the landscape including the human constructed landscape (cultural heritage values). Nature provides opportunities for spiritual enrichment, aesthetic enjoyment, cognitive development (contemplation, meditation) and recreation. Different from the provision of physical space as in carrying functions, these functions refer to the meaning (significance) associated with the biophysical environment. The world's largest economic sector, tourism, is largely based on this function – that is human appreciation of nature and landscape. Examples include aesthetic information (scenery, landscape), spiritual and religious information (religious and sacred sites), psychological information (emotional attachment, nostalgic attachment to place), historic information (historic and archaeological elements), cultural and artistic information (inspiration for folklore, music, dance, art), and educational and scientific information (natural science classes, research, environmental indicators).

The difference between the 'classical' approach to describe nature in terms of natural resources (water, soil, forest, etc.) and function-evaluation is that the latter provides much more insight in the multifunctionality of resources. For example, instead of just describing the resource, 'water', function evaluation provides insight in the multiple functions of water, such as production function for agriculture, carrying function for shipping and recreation, regulation function to counterbalance seawater intrusion, and signification function for science or religious groups or nature-based tourism. By identifying the functions, the relevant units of measurement can be identified and decision making can be based on a more profound understanding of the role that the biophysical environment plays for human society. It is important to realise that many functions can occur simultaneously (see example for water above), but that with human intervention these functions may become mutually exclusive. The creation of a dam to enhance water storage in a river basin will block the pathway for migratory fish as well as for long-river water transport. Intensive exploitation of freshwater for agricultural productivity will reduce or exclude other functions such as shipping, balancing the intrusion of seawater, maintenance of downstream wetlands, etc.

The social setting

The social setting creates the demand for environmental goods and services. The existence of goods and services that derive from environmental functions is what determines the perceived value of those functions for humanity. This perceived value is also related to what is socially valued in that society, which in turn, is related to the culture of that society, the level of technology and so on. Three broad categories of values can be distinguished: social values, economic values and ecological values.

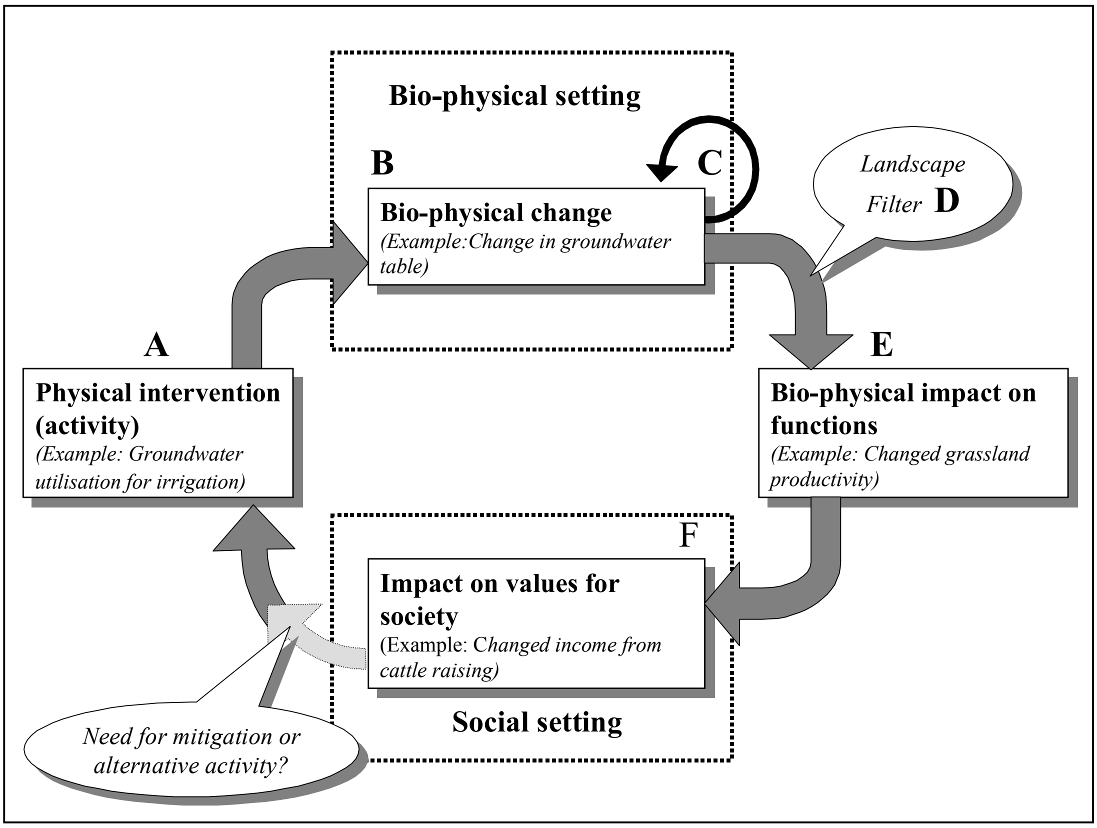
(1) Social values refer to the quality of life in general and can be expressed in many different units, depending on the social context and cultural background of the situation/society. Some examples are health and safety (expressed as prevalence of diseases or number of people protected from forces of nature), housing and living conditions, space for settlement, the value of the environment as a source of food (or in-kind income) in subsistence economies, religious and cultural values, etc.

(2) The economic value of an environmental function refers to the monetary value of the goods and services that are provided. It can be expressed as a monetary value assigned to individual economic activities (agriculture, industries, fisheries, construction), to household income (as an overall indicator on the financial conditions of the population), or to per capita Gross Regional or Domestic Product, as an overall indicator for the income of the society as a whole.

(3) Ecological values refer to the value that society places/derives from the maintenance of the earth's life support systems (particularly the processing and regulation functions). They come in two forms. ***Temporal ecological values*** refer to the potential future benefits that can be derived from biological diversity (genetic, species and ecosystem diversity) and key ecological processes that maintain the world's life support systems for future generations. The appropriate way(s) to express these values is hotly debated. A simple, regularly used measure is the proportion of endemic species (i.e. only locally occurring species) as a measure for uniqueness of the area. Other measures try to indicate the 'naturalness' of an area, i.e. the level at which natural processes can still structure and maintain the environment and its functions. ***Spatial ecological values*** refer to the interactions ecosystems have with other systems, and thus perform functions for the maintenance of other systems. Coastal lagoons and mangroves that serve as breeding grounds for marine fish provide a good example. The ecological value of the mangroves is the support they provide for economic activity elsewhere – without mangroves there would be less fish. Other examples are wintering areas for migratory birds or flood plains that recharge groundwater aquifers for neighbouring dry lands or act as a silt trap that prevent downstream rivers and reservoirs from silting up.

These values are not mutually exclusive, since functions can not always be unequivocally assigned an economic or a social value. For example, the suitability of a certain area for a traditional crop (production function) can be valued in economic (e.g. income, employment, subsistence) as well as social terms (e.g. cultural preservation), or even in ecological terms (e.g. the use of a traditional and unique variety of salt resistant rice that merits to be maintained in a seed bank for future uses). It is important to realise that values differ for different (groups of) individuals in a society. Therefore, the identification of values should include the views and opinions of many people.

Figure 2: steps in determining impacts resulting from physical interventions.



influence on the biophysical setting, or on the social setting.

In impact assessment, we are interested in predicting the environmental (biophysical and social) impacts of such planned interventions. There are several key questions for impact assessment:

1. How can social and biophysical impacts be integrated in one process, and more importantly, how are social and biophysical impacts interlinked?
2. What are the chains of events that lead from a proposed intervention to expected impacts?
3. Can second and higher order effects be identified?
4. Can off-site impacts (away from the site of the intervention) be identified?

Interventions, changes and impacts

As shown in Figure 1, imbalances between the supply of goods and services provided by the biophysical environment and the demand for these goods and services from society may lead to the identification of an actual or a perceived current or future problem or opportunity. The problem or opportunity, in its turn, will trigger a reaction from the institutional setting to undertake interventions (or activities, projects, etc.) to address the issue. Interventions may be designed to have direct

We use the function evaluation framework as a way of understanding how impacts develop from physical interventions. Separating the concepts of a change in the biophysical setting from the impact to the environmental functions, and the impact experienced by people as a result of those biophysical impacts, is useful (see Figure 2).

Figure 2 shows that physical interventions (A) create changes to the characteristics of the natural resources in the biophysical setting (B). These ***biophysical changes*** can be measured and quantified. A change in the characteristics of a natural resource will occur under all circumstances, irrespective of the type of ecosystem or land-use type in which the intervention is carried out. For example, a project (intervention) which will divert water from one watercourse into another will change the downstream hydrology (the biophysical change), whether it be in the Amazon River, a mountain stream (natural ecosystems), or an irrigation feeder canal (an artificial land-use type). Magnitude and direction of change are determined by the combined characteristics of the intervention and the natural resource involved. This conceptual framework, however, only allows for the identification of **likely** biophysical changes. Field observations and detailed information on the proposed interventions are needed to determine the actual magnitude and the direction of the change.

The biophysical change that directly results from an intervention is a ***first-order change***. This change may in turn cause ***second and higher order*** biophysical changes (C). As in the example above, a river diversion is likely to result in a change in river hydrology (first order change); the change in hydrology may lead to a change in flooding regime in downstream floodplains, or change the salt and other pollutant concentration along the river (second order changes).

The example in Figure 2 shows that changes in the physical and biological properties of natural resources will change the functions of the natural environment (E); i.e. the goods and services provided by nature. These changes are called the ***biophysical impacts***. The type and quality of the biophysical environment determine the functions affected. For example, a change in groundwater level in forested upland areas will affect functions such as wood production, and the provision of water for lowland areas. In coastal lowlands, however, the same biophysical change in groundwater level will affect functions such as the prevention of underground seawater intrusion, and productivity of meadowlands. From this framework, then, a long list of potential impacts can be derived for all imaginable environmental conditions. However, field observations are needed to confirm or reject the potential impacts.

With some knowledge of the specific location, it would be possible to improve the identification of potential impacts by using the concepts of ***ecosystem*** and ***land-use type***. By knowing the ecosystem or land-use type in which a biophysical change occurs, it would be possible to indicate the functions that potentially will be affected. The long-list of potential impacts can thus be narrowed down considerably by introducing a so-called ***landscape filter*** (D). For practical reasons, the combined term landscape is used, being defined as a biologically and/or geographically recognisable unit representing either a natural ecosystem (for example a lowland rainforest), a semi-natural ecosystem (such as managed forest) or a human land-use type (irrigated cropland). This landscape filter 'filters' the relevant impacts from the long-list of potential impacts.

When the first and higher order biophysical changes that result from an intervention are known, the area of impact can be determined. Many changes will only occur in the area where the intervention is carried out and will result in ***on-site impacts*** that can be determined when the landscape type in which the intervention is carried out is identified. But, some biophysical changes will have a broader geographical range of impact. For example, air pollution drifts to other areas by wind; interventions in river hydrology may have impacts on the entire river basin (upstream and downstream); an airport or road produces noise that travels along noise contour lines. For each physical change, the ***geographical range*** where changes can be expected can be defined. By defining this range, the so-called ***off-site impacts*** of any intervention can be determined. An example is the geographical range of a change in peak discharge of a river downstream from an intervention site. By determining the landscape types that lie downstream of the intervention site and that depend on river water, the off-site impacts can be determined. If, for example, the peak discharge will be significantly diminished, the identified downstream floodplains will suffer from reduced or total absence of flooding, and the estuary where the river empties will experience a change in the fresh-salt water balance. The impacts in each landscape type will be very different, but they result from the same intervention and the same biophysical change.

Biophysical impacts are expressed in terms of changes in the products and services provided by the environment and will consequently have impacts on the values of these functions for human society (F). Changes in the *functions* of nature will lead to changes in the *values assigned* to nature. For example, when, due to the construction of a dam, the surface area of floodplains downstream changes (physical change), downstream fish productivity will change (biophysical impact) which in turn influences society, i.e. a change in the economic livelihoods of downstream fisherfolk. These impacts on society are considered to be **indirect human impacts.** The word 'indirect', in this case, refers to the fact that the impact on humans takes place through biophysical changes and impacts, in contrast to the direct impacts where the proposed intervention directly leads to changes and impacts in society.

The word 'human' instead of 'social' is introduced to avoid semantic discussions on what should be considered 'social' impacts. **Human impacts** are the real and perceived impacts experienced by humans (at individual and higher aggregation levels) as a result of biophysical and/or social change processes caused by planned interventions. We assume that human impacts encompass all final impact variables that are studied in environmental impact assessments, social impact assessments, health impact assessments, and even biodiversity impacts assessments given that the maintenance of biological diversity (a function of nature) is presently valued by society (as an ecological value) to guarantee the livelihoods of future generations.

Decision making in relation to a proposed project is (should be) based on the assessment of all these values, and on possibilities to define alternatives or mitigation measures in the case of undesirable impacts. Changes to the proposed intervention, or the implementation of mitigation measures is a new intervention, making the process circular. Over time, too, the type of new projects that are proposed (A) is dependent on the experience of past interventions (F).

Social change processes and human impacts

Above, we have presented a framework to derive human impacts that result from physical interventions (changes to the biophysical setting). We now elaborate further the framework to also address the human impacts that result from social interventions (changes in the social setting). Among SIA practitioners, there is general agreement that social impacts relate to "all social and cultural consequences to human populations of any public or private actions that alter the ways in which people live, work, play relate to one another, organise to meet their needs, and generally cope as members of society" (Interorganizational Committee, 1994, page 107). In contrast to biophysical impacts, human impacts can occur as soon as there are changes in social conditions, even from the time when a project is anticipated. People don't simply experience social changes, they react to them and are able to anticipate them. This makes prediction of social changes and human impacts difficult and situation specific. As a consequence, and for many other reasons elaborated by Burdge and Vanclay (1995), too many social impact assessment studies have been inadequate, often presenting little more than demographic or economic predictions.

In the context of our approach, human impacts should be seen in the broadest sense. This means that they refer to quantifiable variables such as economic or demographic issues, as well as to changes in people's norms, values, beliefs and perceptions about the society in which they live, the gendered differentiation of impacts and all other facets of life. See Vanclay (1999) or Vanclay, van Schooten and Slootweg (2000) for a full discussion of the nature of human impacts.

Analogous to the distinction between biophysical changes and biophysical impacts in the biophysical setting, we argue that a distinction between **social change processes** and **human impacts** should be identified in the social setting. Policies or project interventions cause social change processes. These can be intended (e.g. conversion of economic activities) or unintended (e.g. job loss). In our opinion, social change processes take place regardless of the social context of society (groups, nations, religions or whatever). The resettlement or relocation of local people due to the building of a dam, or the influx of new residents whether permanent, seasonal or weekenders, are social change processes, and are not in themselves social impacts. Under certain conditions, depending on the characteristics of the existing community and the nature of mitigation measures, these social processes may cause impacts. There is, therefore, a distinction to be made between social change process and human impacts that is rather akin to the difference between biophysical changes and biophysical impacts. Conceptually too, it is obvious that an 'impact' has to be experienced or felt in corporeal (physical) or cognitive (perceptual) sense, whether at the level of individual, household, or society/community. An increase in population, or the presence of strangers, is not the experienced impact, the experienced impact is likely to be changed perception about the nature of the community (communityness, community cohesion), changed perception about personal attachment to the community, and possibly annoyance and upsetness as a result of the project. The ways in which the social change processes are perceived, given meaning, or valued, depends on the social context in which various societal groups act. Some sectors of society, or groups in society, are able to adapt themselves quickly and make use of the opportunities of a new situation. Others are less able to adapt themselves (e.g. various vulnerable groups) and will bear most of the negative consequences of change.

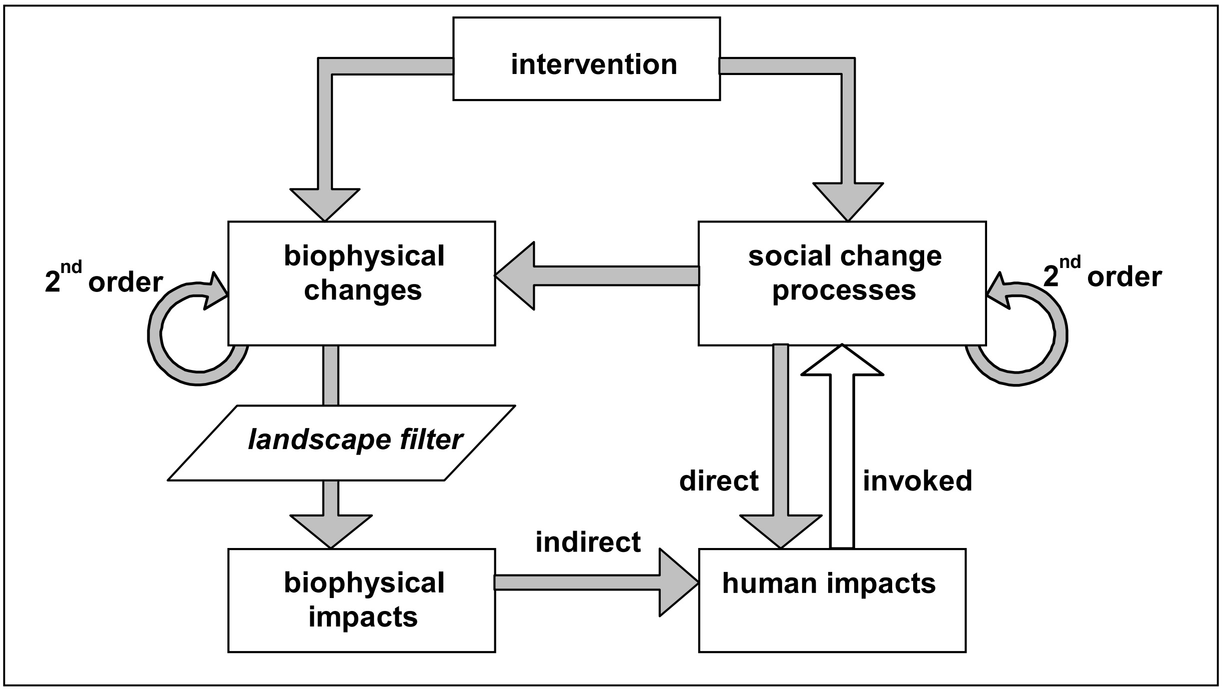


Figure 3: pathways to derive biophysical and human impacts

Integrating the biophysical and social settings

Figure 3 presents a revised version of the framework combining all elements, the biophysical setting, the social setting, and interlinkages – in particular showing that the social setting can be influenced by interventions through two pathways: indirect and direct. **Indirect human impacts** result from changes in the natural resource base and the derived functions, i.e. from biophysical impacts. **Direct human impacts** originate directly from (social) interventions (via the social change processes), and are either especially designed to influence the social setting (objectives) or are an unintended consequence of the intervention.

Change has a way of creating other changes. This notion of circularity or iteration has been incorporated in the framework in several ways. Social change processes that result directly from the intervention, the so-called **first-order changes**, can lead to (several) other social change processes, the **second and higher order change processes**. For example, resettlement can lead to processes of rural to urban migration and changes in food production. In addition, the social experience of change (that is the human impacts) can also provoke people to undertake other behaviour or further social change processes. For example, the negative human impacts (experiences) associated with unemployment can activate the social change process of rural to urban migration in search of work.

Social change processes can also provoke biophysical changes. Economic developments which increase the number of tourists in a particular area can have serious influence on land use and water quality, which in their turn, can have indirect human impacts through a reduction in agricultural production and subsequently on income level for smallholder farmers.

A social filter?

So far, there has been a close comparison between the biophysical setting and the social setting. Somewhat analogous to the landscape filter in the biophysical setting, we can conceive of a **social group filter**. The aim of such a filter would be, that by using information about the types of social groups present, it might be possible to narrow down the long list of potential human impacts and to identify the relevant impacts for that group. The filter would be placed between the social change processes and the human impacts and between the biophysical impacts and the human impacts (see Figure 3).

Conceptually, this is straightforward especially once the logic of the framework is accepted. However, the construction of such a social filter in any practical application of this framework appears to be very complicated, and there is resistance amongst SIA professionals to consider the possibility. In the biophysical setting, biophysical impacts are related to ecosystems and landscape types. The classification of ecosystems or landscapes into meaningful units is reasonably established and accepted amongst EIA professionals and the ecology discipline. In contrast, there is not a generally accepted classification of social groupings for which sufficient knowledge exists to make predictions about the likely experience of human impacts. Further, landscape or ecosystem units have common elements around the world, but cultural groupings tend to be unique in many respects.

It is clear that the concept of a social filter still needs further thinking. The fact that most (all?) social scientists who have worked for some time in a community can identify vulnerable groups, or can predict (to a certain extent) the likely effects of a specified intervention, proves that intrinsic social filter mechanisms exist. The challenge is to articulate and operationalise the criteria that underlie this intrinsic knowledge.

What's new with our approach?

The framework presented in this paper is an attempt to provide a means to structure social and biophysical knowledge in impact assessment. It should be stressed that <u>it is not a procedural framework for impact assessment and that it is not a predictive model</u>, but rather it is a way of thinking. Impact assessment has always dealt with the identification of the cause-effect chains that may result from a planned intervention. By providing an integrating framework that combines the biophysical and the social aspects of impacts, we hope that the separate worlds of EIA and SIA can join forces for better impact assessment, better project design, and hopefully to bring about better livelihoods for present-day and future people.

We have deliberately introduced the term ‘human impact’, so as to avoid the sometimes difficult and unfruitful discussion about whether SIA encompasses EIA, or whether EIA should encompass both the social and the biophysical dimensions. It is our strong conviction that all impacts are human impacts, but the pathways through which these impacts arise can be complex and include both the social and the biophysical settings. It makes no sense to separate the biophysical from the social environment.

The framework forms the basis of a computerised instrument that assists in identifying (qualitatively) the potential impacts of proposed projects. For that purpose, the authors have been forced to create a rigid and unequivocal framework of thinking. In doing so, it was realised that the analytical side of EIA and SIA practice could be strongly enhanced. Very often, implicit knowledge is used in both EIA and SIA without this being realised. For example, in many terms of reference for EIA studies, impacts on water quality are considered negative impacts, without any statement of the reasons why this should be the case. Implicitly, water is assumed to have functions for public water supply, irrigation or for fisheries. Would water quality be an issue if the water would drain into an uninhabited area without any living organisms?

The rigid division between change processes (being tangible, objectively verifiable and measurable processes) and impacts (as subjective, context dependent final variables of impact studies) provides considerable analytical assistance in the early identification of potential impacts. It adds something new to both EIA and SIA. EIA studies usually stop at the level of biophysical changes, such as changes in the quality or quantity of air, water, or soils. The notion of functions provides a mechanism to translate these changes into explicitly identified issues that are of relevance to human society. Water quality *per se* doesn’t provide insight; the functions of this water and its values for society provide the relevant information. For SIA studies, the separation of social change processes from the experience of (social or human) impacts is new. Many social scientists state that each situation is unique and that SIA studies are by definition context specific. However, nobody will doubt that inundation of populated areas will cause migration if not relocation, or that the creation of new factories will increase employment opportunities. These change processes do not give any clue as to the nature and severity of impacts that may be expected. This depends on the context of different groups in society and should be subject to SIA studies.

We believe that the framework presented in this paper provides a useful tool in the identification of issues that should be subject to impact studies. It also provides the means to focus on relevant issues thus avoiding lengthy scoping processes, and it reduces the risk of overlooking important issues. Furthermore, by providing simple and clearly defined links between the biophysical and social environments, the division of tasks and the communication between members of multidisciplinary study teams can be greatly enhanced.

Acknowledgements

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APPENDIX 1

Glossary of working definitions for terminology used in the framework

The terminology in this paper is only used to distinguish steps in the presented framework. The authors make no pretensions as to the wider meaning of the terms. In order to avoid semantic discussions on terminology, we use the following working definitions:

- ***Physical intervention***: planned human activity that physically intervenes in, and possibly alters the biophysical environment.
- ***Social intervention***: planned human activity that intervenes in, and possibly alters the social environment.
- ***Biophysical change***: change in the characteristics of a natural resource – including soil, water, air, flora and fauna – resulting from a physical intervention.
- ***Biophysical impact***: change in the quality (or quantity) of the goods and services that are provided by the biophysical environment, that is a change affecting the functions of the biophysical environment.
- ***First order change***: change that results directly from the intervention.
- ***Second and higher order changes***: changes that may result from the first order change through a causal chain of events or processes.
- ***Landscape type****:* a recognisable area with a consistent set of natural, semi-natural or managed resources: water, land, climate, and flora and fauna.
- ***On-site impacts***: impacts resulting from a physical (or social) intervention that occur in the area where the intervention is conducted.
- ***Off-site impacts***: impacts caused by a physical (or social) intervention, but that occur away from the location where the intervention is conducted, due to biophysical or social changes that influence distant areas. Off-site impacts are usually, but not necessarily always, second or higher order impacts.
- ***Social change process***: a discrete, observable and describable process which changes the characteristics of (parts of) a society, taking place regardless of the societal context (that is, independent of specific groups, nations, religions etc). These change processes may, in certain circumstances and depending on the context, lead to the experience of human impacts.
- ***Human impact***: the effect resulting from social change processes or biophysical impacts, as experienced (felt) by an individual, family or household, community or society, whether in corporeal (physical) or perceptual (psychological) terms.
- ***Direct human impacts****:* human impacts that result directly from an intervention through social change processes. They may be the intention of specially designed interventions to influence the social setting (intended impacts, project goals, objectives), or may unintentionally result from the interventions (unintended consequences).
- ***Indirect human impacts****:* result from changes to the biophysical environment, affecting the functions that the environment provides to people.
- ***Invoked social change processes***: because of the ability of people to act in response to perceived or real impacts, human impacts may in their turn cause other social change processes to occur.