The Biodiversity Assessment Framework

1 Introduction

1.1 Biodiversity

Biodiversity encompasses all living organisms on earth (flora and fauna), their interactions, and the interaction with the physical environment (soil, water, air). Human beings are part of biodiversity since they are living creatures, in continuous interaction with the environment, ánd dependent of biodiversity for their survival.

Biodiversity produces the oxygen we breath, regulates water supplies, sequestrates greenhouse gasses and thus is responsible for regulating climate, provides food such as fish, shellfish, and (bush)meat, but also provides products such as timber or raw materials for pharmaceutical industries, constitutes a source of genetic material of use to maintain the long term productivity of our agricultural crops (themselves also being part of biodiversity), is a source of inspiration, recreation and highly contributes to the quality of our day-to-day lives. These examples are given to illustrate that human existence is impossible without biodiversity and to show that biodiversity is not a complicated concept but a visible reality surrounding and supporting us.

Box 7.1: Use of some terms in the Convention on Biological Diversity (Article 2):

- Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includ es diversity within species, between species and of ecosystems.
- Biological resources includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.
- Domesticated or cultivated species means species in which the evolutionary process has been influenced by humans to meet their needs.
- Ecosystem means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.
- Ex-situ conservation means the conservation of components of biological diversity outside their natural habitats.
- Genetic resources means genetic material of actual or potential value.
- Habitat means the place or type of site where an organism or population naturally occurs.
- In-situ conservation means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.
- Sustainable use means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

1.2 International attention

In spite of the above, mankind has treated biodiversity rather carelessly over the last centuries, caused by unsustainable exploitation of natural resources and an exploding world population. The present rate of extinction of species is estimated to be about 1000 times the natural rate in which species have disappeared during evolution. Scientific observations learn us that diversity contributes to stability and buffering; a loss of diversity (loss of species) consequently leads to more instable ecosystems that are more easily pushed out of balance. Life support processes become less reliable.

The rapid loss of biodiversity has received increased attention and in recent years a number of guiding principles were formulated that define the way in which we should deal with biodiversity. Two important principles are:

- The principle of "**no net loss**" of biodiversity. Any further decline in biodiversity should be considered negative or undesirable. New human activities should not lead to further decline of biodiversity.
- The **precautionary principle**. There are many unknowns about the processes that influence biodiversity, particularly at ecosystem level. In areas with high biodiversity value only activities with limited or no impact on biodiversity should be allowed to be carried out. If impacts cannot be established with sufficient certainly, the activity should be halted as a precaution until enough information is available.

The application of these principles is seriously hampered by the lack of an unambiguous instrument to define human impacts on biodiversity. As long as such an instrument is not available, the no net loss principle cannot be further operationalised; the application of the precautionary principle will lead to social resistance as long as it remains unclear for private enterprises and other parties how to define and measure the biodiversity impacts of their activities.

A relevant recent development is the focus on possibilities for restoration of biodiversity in areas heavily degraded by human activities. Also under such conditions it is important to properly define biodiversity impacts of activities.

1.3 The "Biodiversity Assessment Framework" project

A multitude of tools and techniques has emerged in recent years to predict, measure, or report on human impacts on biodiversity. Examples are environmental impact assessment, audits, sustainability reporting, certification, etc. These instrument have been developed for different purposes and all have there own procedures, methods and techniques. As stated before, these instruments are not always based on an unambiguous interpretation of biodiversity.

As the Convention on Biological Diversity has provided clear definitions and supporting documents on what biodiversity is, it should be possible to judge whether the above-mentioned instruments comply with the agreements under the convention. For example, the ecosystem approach has been endorsed by the convention; yet, this approach has so far hardly ever been translated into practical instruments. Nevertheless, the approach has far-reaching consequences in the way biodiversity impact should be dealt with.

The objective of the "Biodiversity Assessment Framework" project is to formulate a general assessment framework that provides an all-encompassing analytical framework to identify the potential biodiversity impacts of any imaginable human activity. The framework departs from the CBD objectives and uses the ecosystem approach as a conceptual "umbrella" (see box 2), recently further elaborated for sustainable use in the so-called Adis Abeba principles.

1.4 What does the assessment framework do?

The above implies that the assessment framework describes:
- the principles for an analysis of biodiversity impacts of human activities;
- how to perform such an analysis in order to comply with these principles;
- the type of information that is needed.

It is important to realise that the project does not intend to replace existing instruments by a new instrument; it merely creates a framework to appraise existing instrument. When instruments do not comply with the principles of the biodiversity convention, such an appraisal may lead to suggestions for improvement. Of course, when instruments for biodiversity assessment are totally lacking, the framework provides the necessary background to develop such biodiversity assessment instruments.

The development process of the assessment framework is divided into 4 stages; each stage results in a product aimed at narrowly defined target groups (see table 7.1).

Stage 1: Conceptual framework providing the scientific translation of the various internationally accepted documents into one coherent approach.

Stage 2: General Assessment framework (this document) describing general principles and analytical steps to identify biodiversity impacts of human interventions.

Stage 3: Task-oriented modules, translating the general framework into existing procedures for, for example, sustainability assessment or certification of products, biodiversity reporting, etc.

Stage 4: Practical applications; large enterprise or sector organisations evaluate their own instruments and/or develop their own sector or product oriented applications.

Finally it should be realised that the biodiversity assessment framework needs to be put in the perspective of corporate social responsibility. The present framework focuses on biodiversity related aspects, but conceptually it provides the opportunity to enlarge the scope of the framework to all aspects of socially and environmentally responsible entrepreneurship.

Box 2: The ecosystem approach as adopted by the 187 parties of the Convention on Biological Diversity, by decision 6 at the 5th Conference of Parties.

The Ecosystem Approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in and equitable way. An ecosystem approach is focused on levels of biological organisation which encompasses the essential processes, functions and interactions among organisms and their environment. It recognises that humans, with their cultural diversity, are an integral component of ecosystems. The definition of ecosystem does not specify any particular spatial unit or scale, but can refer to any functioning unit at any scale. Indeed, the scale of analysis and action should be determined by the problem being addressed. The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Adaptive management must be able to respond to such uncertainties and contain elements of "learning by doing". As with the precautionary principle, measures may need to be taken even when some cause-effect relationships are not fully established scientifically.

Principles of the ecosystem approach:

1. The objectives of management of land, water and living resources are a matter of societal choice
2. Management should be decentralised to the lowest appropriate level
3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
4. Recognising potential gains from management there is a need to understand the ecosystem in an economic context. Any ecosystem management programme should 9a) reduce those market distortions that adversely affect biological diversity, (b) align incentives to promote biodiversity conservation and sustainable uses, and (c) internalise costs and benefits in the given ecosystem to the extent feasible.
5. A key feature of the ecosystem approach includes conservation of ecosystem structure and functioning.
6. Ecosystems must be managed within the limits of their functioning.
7. The ecosystem approach should be undertaken at the appropriate scales.
8. Recognising the varying temporal scales and lag-effects that characterise ecosystem processes, objectives for ecosystem management should be set for the long term.
9. Management should recognise that change is inevitable.
10. The ecosystem approach should seek the appropriate balance between conservation and use of biological diversity.
11. The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practises.
12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

Operational guidance for application of the ecosystem approach:

1. Focus on the functions of (biodiversity in) ecosystems.
2. Promote the fair and equitable sharing of the benefits derived from the functions of (biological diversity in) ecosystems.
3. Use adaptive management practises.
4. Carry out management practises at the scale appropriate for the issue being addressed, with decentralisation to lowest level as appropriate.
5. Ensure inter-sectoral cooperation.

Table 1: Products of the "Biodiversity assessment framework" project, their uses and target groups. Practical applications will not be developed during this project phase; however, a number of existing instruments will be evaluated using the assessment framework.

Product	***Use***	***User***
1. Conceptual framework **2. General Assessment framework** (this document)	Scientific document based on CBD objectives and state of the art ecological knowledge. General principles and analytical steps that modules and other products should comply with.	• Members of steering group who watch over the scientific validity and compliance with CBD objectives. • Background document for specialists who develop modules. • Module developers • Background document for developers of applications.
3. Task-oriented modules used for: • analysis of processes and products • criteria development for certification or codes of conduct • environmental impact assessment • etc.	Manuals describing how the assessment framework can be put into practise for specific purposes.	• Application developers such as certification agencies or environmental departments within large enterprises.
4. Practical application for a specific sector, certification agency, etc.	Introducing biodiversity assessment in a narrowly defined situation, for example, in a large enterprise, in a branch organisation, or for a group of products.	• Those responsible for the social and environmental responsible entrepreneurship within enterprises and organisations.

Throughout the following text the links with the principles and operational guidance provided by the ecosystem approach (ES) and the Adis Abeba principles (AA) will be indicated between brackets. The conceptual framework document in chapter 8 (in Dutch only) provides more elaborate linkages.

2 General principles

A. Biological diversity: the challenge

The Convention on Biological Diversity forces parties to formulate and implement policies for the protection of:

- Ecosystems containing (i) rich biodiversity, (ii) large numbers of threatened or endemic species, with social, economic, cultural or scientific significance, or (iii) relevant for key processes such evolutionary processes, and (iv) ecosystems of relevance to migrating species;
- Species and communities of species that are (i) threatened in their existence, (ii) related to domesticated or cultivated species, and (iii) species with medicinal, agricultural, or other economic, social, cultural or scientific significance, and (iv) indicator species.
- Genotypes with social, scientific or economic significance.

Each contracting party shall, as far as possible and as appropriate, identify components of biological diversity important for its conservation and sustainable use, and identify processes and categories of activities which are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects.

B. Objectives of the Convention on Biological Diversity: conservation, sustainable use, and fair and equitable sharing of benefits.

The 187 Parties of the Convention have agreed on the triple objective (Article 1):

- to the conservation of biological diversity,
- to the sustainable use of its components,
- and to the fair and equitable sharing of the benefits arising out of the utilisation of biodiversity.

The assessment framework strictly follows the CBD objectives, translating these into a practical instrument.

C. Functions of biodiversity: products and services
(ES principles 6 and operational guidance ; AA principle 5, underlying condition 1)

The living environment (= biodiversity) provides goods and services of importance for human society. Examples of such goods and services, also referred to as functions of biodiversity, are:

- Harvestable goods such as fish, timber, bush meat, fruits, genetic material; these are often referred to as production functions. Agriculture, fish farming and plantations are examples of production functions that needs additional human inputs.
- Safeguarding certain areas against forces of nature such as coastal protection by mangroves; maintenance of processes such as climate regulation, or regulation of water runoff; natural purification of water; maintenance of biodiversity itself. These functions are referred to as regulation functions.
- Suitability of areas for certain activities such as dwellings, recreational activities, nature conservation, referred to as carrying functions.
- Biodiversity is a source of spiritual, religious, recreational or scientific "information". For example, a large proportion of the tourism industry depends on this service provided by biodiversity. Referred to as signification functions

Ecosystems are by definition multifunctional; an area is providing more than one good or service simultaneously. (Example: a forest provides timber and other forest products, maintains populations of birds and invertebrates, is being used for recreational purposes, is an important regulator for rainwater storage and runoff, and protects the soil against erosion.) Forest management may be set to maximisation of one function (for example timber production) or to the maximisation of a combination of functions (for example less intensive timber production in order to maintain a bio-diverse forest, interesting for hikers, with minimal soil erosion and optimal water regulation for the protection of downhill villages). Maximisation of a combination of functions leads to an optimisation of each individual function.

Each intervention for the enhancement of one function, such as irrigation for enhanced agricultural soil productivity or selective logging and planting in forestry, will by definition lead to a change in the suite of functions of that ecosystem. The Biodiversity Assessment Framework assists in picturing the human induced changes in functions and identifies information needs for transparent decision making.

D. Values of biodiversity: more than money
(ES principle 1 & 4; AA principles 10, 12 & 13)

The functions of biodiversity described under principle C represent various societal values:

- Economic values: (i) direct monetary income, for example by selling of products (timber, fish); (ii) input in other economic activities by providing raw materials; (iii) indirect by providing services that would require large investments if not present (water purification, coastal protection, buffering of precipitation, etc.)
- Social values: such as employment (forestry, tourism, nature management, etc.), safety (protection against tempests), health (air and water quality), quality of life, social security (source of food and income), maintenance of animal and plant life (the idea that species become extinct because of human activities leads to unrest among large sections in society).
- Ecological values, differentiated into (i) future values, or in other words: how do we keep our world a liveable place for our children and how do we leave them the possibilities to utilise the so far unrecognised potential of biodiversity; (ii) spatial values, relevant for the maintenance of other ecosystems. Examples of the latter are the role of coastal mudflats in the reproduction of open sea fish populations, or the buffering of rainwater runoff by upstream wetlands, thus protecting downstream areas from flood damage.

E. Stakeholders: guaranteeing attention to biodiversity
(ES principle 12; AA principle 9)

Goods and services provided by biodiversity represent a value for enterprises, organisations, groups in society or individuals. These parties consequently have an interest (a stake) in the maintenance and/or use of biodiversity. These stakeholders can be divided into direct stakeholders, those that directly benefit from biodiversity, and representatives speaking on behalf of the direct stakeholders (farmers cooperatives, professionals associations, business councils), or speaking on behalf of biodiversity itself (nature conservation groups).

It can be argued that if biodiversity does not have any stakeholders in certain area, biodiversity related issues will not be identified and put on the agenda of decision makers. Identification of stakeholders consequently is of utmost importance in order to get a complete overview of biodiversity related impacts of business activities. A complete overview of impacts in this sense thus includes an inventory of impacts on biodiversity (conservation objective), an inventory of uses of biodiversity (sustainable use objective), and an inventory of impacts on the distribution of benefits derived from biodiversity (fair and equitable sharing objective).

Reasoning from the assessment framework, all ecosystems, all species and all genetic diversity are, a priori, equal. Valuation of biodiversity can only be done in negotiation with stakeholders. In practise, however, forms of valuation have been formalised in procedures and legislation. Protected species, protected areas, delineation of representative areas for certain ecosystems, identification of biodiversity hot spots, these are all examples of ways in which society tries to grasp the complexity of biodiversity and its values for society.

Contrary to the conservation of biodiversity, only limited formalised instruments exist for sustainable use. The Forest and Marine Stewardship Councils (FSC & MSC) are well known examples. The biodiversity assessment framework provides a means to evaluate such instruments in the light of the CBD objectives.

Equitable sharing of benefits accrued from biodiversity is an even more complicate and highly politicised topic. Some experience exists on agreements between pharmaceutical companies and local communities on sharing of revenues from new components for medical use, derived from locally available plant species. The benefits derived from genetic diversity is thus shared equitably.

F. Ecosystem approach: participative delimitation of study area
(ES principle 3, 7 & 8; AA principles 7, 8)

The ecosystem approach as defined by the biodiversity convention is taken as a point of departure in the assessment framework. This implies that delimitation of an area subject to analysis has to be done in consultation with stakeholders (or representatives of stakeholders). Stakeholders are identified on the basis of observed or expected effects of the activity and the subsequent changes in (potential) values of biodiversity for various groups in society.

The range of influence exerted by an activity needs to be defined on a spatial as well as a temporal scale. This range may reach beyond the limits of the area where the activity is taking place, for example with emission into the air or in ground or surface water, or with the disturbance of functions that are vital for the maintenance of other areas. The range of influence can also reach beyond the time horizon of the activity; for example the longevity of nuclear waste or the extremely slow adaptation processes in groundwater flows. The assessment framework provides clues how to determine the range of influence.

The CBD provides an important elaboration of the ecosystem approach for sustainable use of biodiversity in the so-called Adis Abeba principles, further elaborated in 7 underlying conditions and 14 practical principles.

G. Restraint: only study relevant issues

Human activities interfere with an extremely complex and dynamic system. It is often impossible to precisely measure or predict the biodiversity consequences of human activities, especially in rich tropical ecosystems such as coral reefs and rainforests where biodiversity still is largely unknown.

For this reason the biodiversity assessment framework emphasises the identification of situations that possibly result in serious consequences for biodiversity and the subsequent identification of aspects of biodiversity that need to be studied. This to prevent that large amounts of data are gathered, such as for example species lists, without necessarily containing relevant information.

Change and variability are a biological given; it is important to identify and study only those human induced changes that significantly differ from natural variations. Areas where significant changes can be expected need to be included in an in-depth analysis. It is desirable to define threshold values to distinguish between non-significant and significant changes (i.e. the concept of threshold of potential concern). This can only be practically realised in a concrete application of the assessment framework, since such thresholds highly depend on the type of ecosystem under influence. Local experts are needed for the definition of such thresholds.

H. Human interventions: physical and social

Human activities can directly influence the biophysical environment by means of physical interventions (land conversion, extraction of products, emission of pollutants, disturbance by noise, light or soil compaction, introduction of non-endemic or genetically modified species, restoration of biodiversity). Such interventions usually have consequences for biodiversity.

Indirectly, human activities can influence biodiversity by means of social (or economic) activities that result in social (or economic) changes, which on their turn can lead to biophysical changes. For example, temporary or permanent migration (= social change) will result in land occupation and pressure on water resources (= biophysical change); such social changes can be the result from tourism activities, active attraction of migrant labour; tax measures influencing international trade and exploitation of resources; education influences people's behaviour , etc. All these human activities may have intended or unintended, positive or negative impacts on biodiversity. The assessment framework provides an analytical approach to identify these impacts, following the agreements under the CBD.

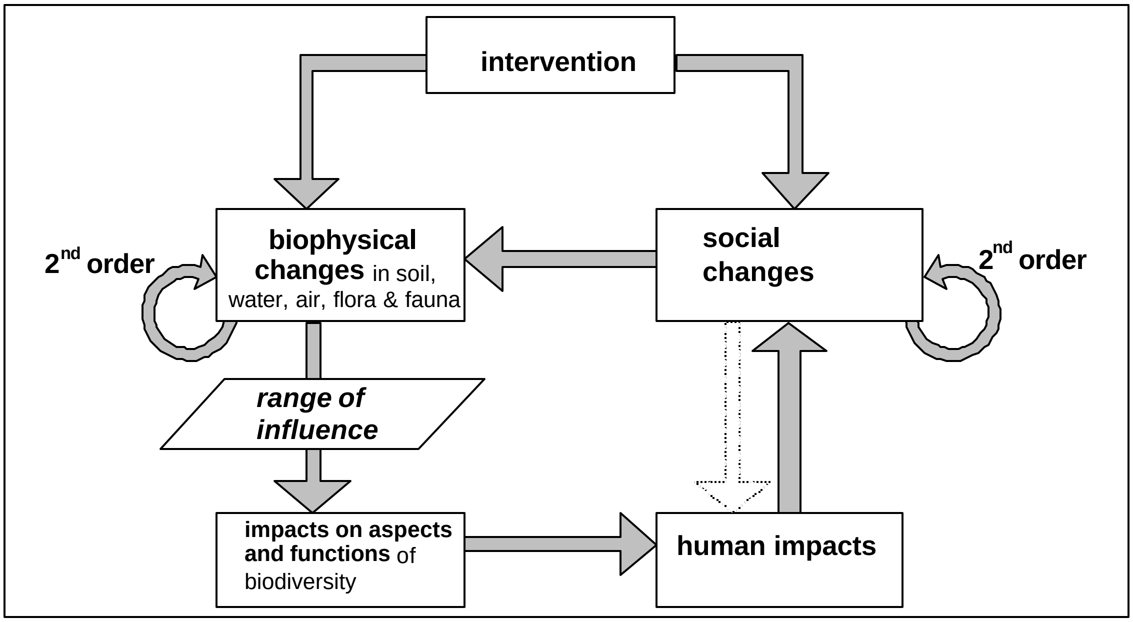

Figure 1: conceptual framework – Physical and social (and economic) interventions lead to biophysical and social changes, each of these potentially leading to higher order changes. Some social changes may lead to biophysical changes. Within their range of influence and depending on the influenced ecosystem(s), biophysical changes may influence different aspects of biodiversity. If impacts on the aspects of biodiversity are significant this has an influence on the functions that biodiversity performs (or the goods and services that biodiversity provides). Impacts on the functions of biodiversity will lead to a change in the valuation of these functions by various stakeholders in society. People can react to these changes in the value of biodiversity functions thus creating new social changes.

I. Biophysical changes: pressures on biodiversity

Human induced changes in the biophysical environment can exert pressure on biodiversity. The assessment framework refers to biophysical changes in:

- Flora and fauna: removal of vegetation, exploitation of plant and animal species, fragmentation of ecosystems, disturbance, etc.;
- Soil: erosion, soil fertility, soil water storage, texture, structure, etc.;
- Water: permanent or seasonal variation in quantity or quality of (flows of) surface and groundwater;
- Air: changes in air quality, micro or macro climatic changes.

J. Aspects of biodiversity: focus for analysis
(ES principle 5; AA principle 5)

Biophysical changes influence certain aspects of biodiversity, that are vital to its maintenance:

- Composition, or what is present. This is the most well known aspect of biodiversity. In practise impact analysis often does not go beyond the description of effects on species composition of higher plant and animal species. Extractive activities directly influence species composition since they usually are aimed at one or a limited number of species (collection of orchids, fishing for tuna, cutting of meranti trees).

- Structure, or how is biodiversity organised. A limited number of aspects are of disproportional influence on the maintenance of biodiversity:
    - ? *spatial structure* and scale of the ecosystem in relation to the scale of the biophysical effect (grain size and extent: for example, local erosion has relatively little impact on a river basin since the eroded material will be deposited somewhere else in the basin; contrary to this, a change in river hydrology by construction of a dam will be noticeable in the entire basin and beyond.
    - ? *foodweb structure and interactions*: the introduction of the predatory non-endemic Nile perch in lake Victoria has upset the entire ecosystem; dozens of fish species feeding an algae have been eradicated, leading to a turbid and locally deoxygenised lake.
    - ? presence of keystone species, being species with a disproportional influence on their environment with limited changes in numbers of individuals (e.g. elephants).

- Key processes, or those processes that are of overwhelming importance for the creation and / or maintenance of ecosystems. For example, a change in the sediment balance on a mangrove coast or a tidal mud flat will immediately alarm ecologist; similarly, changes in the inundation regime of wetlands, the grazing pattern in savannahs, or predation of coral reefs by starfish will ring the alarm bell with ecologists.

If the biophysical changes resulting from an activity are known and the biodiversity aspects that are influenced by these biophysical changes are also known, it is possible to limit an analysis to those issues where most significant impacts can be expected.

K. Information: external experts and local stakeholders
(ES principle 11 & 12; AA principle 4 & 6)

In practise the available information from experts or from scientific sources may show serious gaps. Local and indigenous people can play a role in filling these knowledge gaps. Often these groups make direct use of the biodiversity resources under analysis and poses relevant knowledge on these. The role of local groups in identification and weighing of functions and values of biodiversity is often neglected. As a result functions may be overlooked. Use of local knowledge and exchange of views with local stakeholders are valuable elements of any analysis in order to come to a complete overview of issues.

L. Operational principles

Analysis of a number of existing instruments that also take biodiversity into account (e.g. eco-labels, sustainability reporting, codes of conduct) reveals two operational principles that are important for effective implementation of the instrument. These have nothing to do with biodiversity but nevertheless merit attention:

- Capacity development (AA principle 14): when implementing any kind of biodiversity impact analysis, it is highly recommended to carry out awareness raising and capacity development activities back-to-back with the activity. One cannot expect organisations to implement this instrument at once. Good capacity development is a two-way process in which a learning by doing approach provides relevant input in the practical translation of the principles and analytical steps. Each situation will in the end require its own adapted situation-specific tools and instruments.

- Procedural and organisational embedment (AA principles 1, 2, 3): in order to make effective use of the assessment framework or any instrument derived from it, one must make sure that the instrument is embedded in or adjusted to an existing institutional setting. Roles and responsibilities must be clear, and preferably some sort of quality control system has to be in place to be able to evaluate and adjust procedures, norms and standards.

3 Assessment of biodiversity impacts in 11 steps

A biodiversity assessment according to the steps described below intends to identify any positive or negative impact on biodiversity resulting from human interv entions, and to describe the affected biodiversity values for human society. Apart from the identification of potential impacts, the framework also provides insight in the mechanisms through which these impacts occur, and assists in defining the minimally required information needed to determine the extent and relevance of impacts.

An analysis according to the biodiversity assessment framework can (and should) be applied in an iterative manner; for example each round of analysis can provide more detailed information, starting with a qualitative analysis, later trying to quantify the most relevant impacts. Another ways of iterative use is the assessment of different project alternatives.

Some steps in the framework can only be carried out with the active participation of involved stakeholders, i.e. (groups of) people that have an interest in potentially affected biodiversity. In cases where directly affected stakeholders cannot participate actively, stakeholder representatives such as NGOs may be needed.

It has to be emphasised that the framework can be applied in more or less rigorous manner. Depending on the scope and objectives of an analysis a group of knowledgeable people can use the framework for a quick scan taking only half a day, or it can be used for a full fledged impact assessment study of a large project, taking several months.

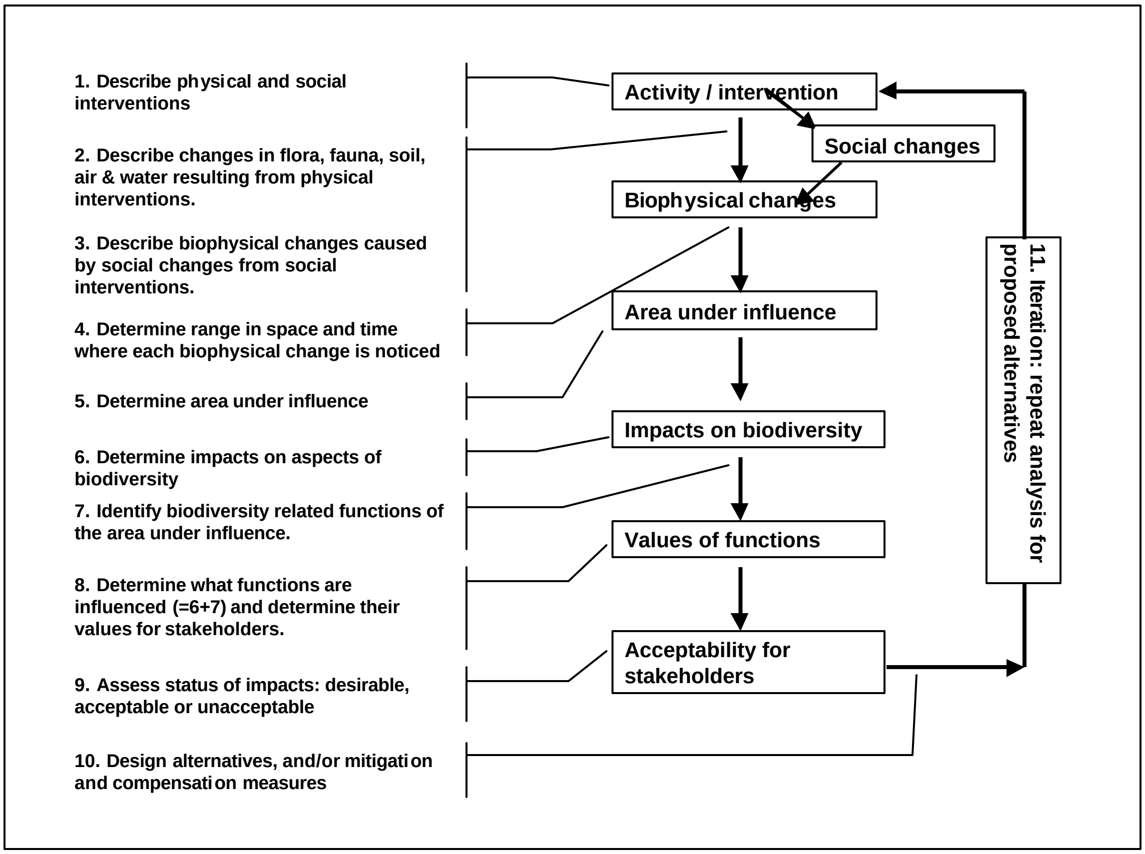

Figure 2: flow chart of steps in an (iterative) analysis

Steps in the analysis
Figure 1 describes the conceptual relations, figure 2 provides an overview of the sequence of analytical steps (flow chart).

Step 1: Description of activities

Describe activities: pay attention to the nature of physical interventions, their magnitude, location, duration and frequency. Also pay attention to social or economic activities that may through social effects lead to physical effects.

Points of attention:
- Identify relevant sub -activities: it should be realised that the implementation of one activity often requires several other activities to be carried out. For example, the dredging of a new port usually also implies (i) the dumping of large amounts of sludge somewhere else, (ii) the excavation or deepening of approach channels, (iii) the construction or improvement of feeder roads or railway lines.
- Chain of activities: an activity can often be part of a chain of activities, for example leading from raw material through various processing steps to a final product, which is marketed and after its life span ends results in solid waste. For a biodiversity assessment it may be necessary to describe and analyse the entire chain; a project proponent than needs to decide on the extent of it's own influence and responsibility.
- History of interventions: some activities may have been preceded in the (recent) past by relatively destructive activities. For example most agricultural or construction work is done on previously converted, drained or reclaimed land. The land conversion is of much more influence on biodiversity compared to the intended activity. Yet, the intended activity cannot be carried out without land conversion so conversion needs to be included in an analysis. An indicator for biodiversity impact can be the time since the conversion has taken place.
- Cumulative activities and scale issues. A single groundwater well will hardly influence groundwater levels; one farmer cutting a plot in the Amazonian rainforest will not threaten the rainforest. However, several hundreds or thousands of such activities do matter. The scale of analysis in such circumstances needs to be put at a higher level. In stead of analysing a single activity, the analysis will be made at a more strategic or policy level, for example for an entire sector in a geographically defined region. Several levels of scale can be distinguished: individual activity, similar activities within a sector, country level, regional level (e.g. the European Union), and global (agreements under CBD or WTO)

How and by whom : each individual activity that can be distinguished needs to be described in detail, based on project design or available documentation on the company process. Proponents usually have this information available.
Available instruments: generic screening criteria for EIA provided by the CBD; elaborated in some detail for several sectors (oil and gas; mining) and countries.
Example: a paper processing industry uses a small river for the intake of processing water. On average 5 m^3/s is taken in. Intake is continuous but may vary from 2 m^3/s to 8 m^3/s.

Step 2: Description of biophysical changes

Biophysical changes. Describe the expected or observed direct effects on soil, water, air, flora and fauna resulting from the physical interventions. Determine whether second and higher order changes are likely to occur.
How and by whom: experts such as hydrologists, soil scientists, foresters, agronomists and ecologists can predict based on scientific knowledge and field observations.
Available instruments: effects on soil, water and air quality are in many instances regulated by legal norms and quality standards. These standards have limited relevance for biodiversity since these are usually designed for human health and safety. Biological effects such as the removal of plants or animals are in some cases regulated (fisheries, forestry).
Example: Intake of process water by the paper mill of the earlier example changes the hydrology of the river; on average water volume drops by 10%, but in dry spells this can increase to 50%. Water levels in the river drop significantly (first order change); second order changes are a drying of riverside floodplains, and reduced supply of freshwater at the river mouth thus allowing seawater to penetrate further into the lower river branches.

Step 3: Description of indirect biophysical changes

Indirect biophysical changes: Describe expected biophysical changes that results from social (or economic) changes. Social changes result from economic or social project activities.
How and by whom: work for specialists such as social geographers / sociologists in collaboration with natural sciences specialists; additional inquiries with affected stakeholders is recommended.
Available instruments: not well developed field of expertise; knowledge and experience predominantly available for transport sector (opening up of untouched areas by road construction leads to influx of migrants, thus putting additional pressure on natural resources).
Example: the construction of a new paper mill creates new employment in an area with low population density. This attracts migrant labourers from other areas that settle in the vicinity of the new activity (social changes) and consequently create additional pressure on the environment by occupying land for housing, gardening, agriculture, etc (indirect biophysical changes).

Step 4: Determination of the range of influence

Range of influence of biophysical changes: for each individual biophysical change the geographical range (area of influence: where and how far away) and time range (when and for how long, permanent or temporary) needs to be determined.
How and by whom: Experts can model biophysical changes or use empirical evidence to predict when and where a biophysical changes will be noticeable. Local stakeholders with their day-to-day experience in the area can have a say in the appraisal of relevance of certain effects. Official norms can provide a legal basis for this.
Available instruments: a large range of scientific and technical means is available to model and predict the scale in time and space on which biophysical changes can be noticed.
Example: the ra nge of influence of a lower water volume in the river, caused by the intake of the paper mill, starts from the intake point, going as far downstream as the change is noticeable; this can be for example down to the confluence of the river with a much larger river, where the change in water volume becomes insignificant. In the example in step 2 the range of influence includes riverside floodplains and the river mouth.

Step 5: Description of the area under influence

Describe the area under influence: describe the types of natural area and/or forms of land-use (i.e. the ecosystems) that are under the influence of biophysical changes. (Mind that man-made ecosystems - often referred to as land use types - can also represent significant biodiversity functions and values).
How and by whom: Each biophysical change can have a different area and timing of influence, and will affect an ecosystem in a different manner. The description consequently has to be done independently for each biophysical change. The work can be carried out by ecologists and geographers in consultation with local stakeholders.
Available instruments: maps, aerial surveys, satellite images, geographical information systems, field observations, local knowledge.
Example: the earlier example describes three different ecosystems under influence: the river, the floodplains, and the river mouth (estuary). It can also be envisaged that the level of groundwater along the river drops influencing agricultural and forested lands along the river.

Step 6: Impacts on biodiversity

Impacts on biodiversity: for the ecosystems under influence, analyse how each biophysical change can affect biodiversity by determining whether the biophysical change has an influence on one of the following components of biodiversity: composition, structure, or key processes.
How and by whom: determine for each impact its (i) significance[1], (i) permanent or temporary nature, (iii) moment of emergence and duration, (iv) reversibility. This needs to done by specialised ecologists.
Available instrument: the CBD guidelines for biodiversity in EIA provide directions. For ecologists it will not be difficult to determine the potential impacts; the main bottleneck in knowledge is to define the significance of the impact. The concept of "threshold of potential concern" provides a good starting point; it has been applied in a limited number of practical situations.

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[1] for example in the European Union birds and habitats directives, significance is expressed in practical terms as the risk of disappearance of a population of a species.

Example: the flooding regime in the floodplains is a key process for the maintenance of wetland biodiversity. A significant change of this regime is an unmistakable signal that biodiversity impacts can be expected.

Step 7: Functions of biodiversity

Functions of biodiversity (goods and services): identify the functions performed by the affected ecosystem; these can be presently exploited functions but also potential future functions. Inherently, stakeholders are (i) local direct users of functions such farmers, fishermen, foresters, or (ii) local beneficiaries of functions such as villagers who live protected against forces by na ture, or make use of irrigation water supplied by a nearby wetland, (iii) distant beneficiaries (food supply and recreational services for urban inhabitants), and indirect stakeholders such as (international) NGOs for nature conservation, scientific institutions and government authorities.
How and by whom: consultation by experts and stakeholders.
Available instruments: a multitude of publications on functions of ecosystems provides guidance; for wetlands and forested ecosystems multifunctionality has been elaborated in detail in a number of cases, including the economic value of functions.
Example: seasonal flooding of wetlands provides sediments and nutrients for soil fertility, recharges the groundwater reservoirs, is essential for vegetation development, provides possibilities for fish reproduction, and facilitates the feeding of large quantities of migratory birds that use this wetlands as a stop-ov er on their flyway. It also maintains the recreational and tourism potential of the area and maintains an appreciated traditional feature of the river landscape.

Step 8: Impacts on values of functions

Impacts on values of functions: By combining the results of steps 6 and 7 it is possible to uncover the functions that will be affected by the activity an d what values these represent for stakeholders (in positive or negative sense!).
How and by whom: with the information from steps 6 and 7 it is relatively easy to find out, in a qualitative manner, which functions will be influenced by the activity. Quantification, however, requires the input of experts. Values of these functions are defined in consultation with stakeholders. Values can differ for different stakeholders, and can be expressed in economic, social or ecological terms; with different valuation by different stakeholders, conflicts of interests may arise. In a negotiation process each of the impacts has to be assigned certain weight. The weighting of impacts can be supported by information from a reference situation. (A reference situation can be (i) the situation without the activity, (ii) a historical situation in cases where the present situation has already been heavily influenced, or (iii) an external reference situation with similar conditions.
N.B: Be mindful of the fact that a situation without an activity may also be subject to changes (= autonomous development).
Available instruments: depends on the functions that are considered of relevance. For most functions expertise is readily available: e.g. fisheries, forestry, hydrology and water quality, ecology, etc.
Example: Direct stakeholders related to the earlier example are of course those that benefit from the activity for which water is being taken from the river, the paper mill, people making a living at the paper mill, and possibly customers of the products. Stakeholders linked to the floodplains under influence are (for example) farmers depending on groundwater for irrigation (economic value), or the public water supply company from a nearby city (social value), the association of fishermen (economic value) because fisheries potential of wetlands and the river is diminishing if flooding reduces, recreational fishermen, nature protection groups (ecological value because of the migratory birds), local recreational companies (boat rental, restaurants, hotels) because they fear loss of income from tourists or day trippers, etc. etc. This example shows that an ecosystem approach aimed at the identification of functions of biodiversity in a well defined area provides a simple means to identify all relevant stakeholders.

Step 9: Acceptability of impacts

Acceptability of impacts: In consultation with stakeholders the status of impacts has to be defined; which impacts are desirable, which can be accepted, and which are unacceptable. The status can differ for different stakeholders, so potential conflicts of interests can be identified.
How and by whom: Attention: This step intends to provide relevant information for decision makers, either in public administration or in corporate management; it is NOT similar to decision making.

Stakeholders have an important role in providing information, but they are not the ones making final decisions on the way in which an activity is carried out.

Step 10: Alternatives and mitigation

Alternatives and mitigation : design alternative project activities in order to avoid or reduce the unacceptable impacts, or to enhance the positive impacts. In case an alternative project design is impossible, try to design additional mitigation measures that counteract or compensate negative impacts.

Step 11: Iteration

Iteration: repeat the sequence of analytical steps with the identified alternatives or mitigation measures and adjust the information accordingly.

For more information :

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