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A generic approach to integrate biodiversity considerations in screening and scoping for EIA

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Abstract

The Convention on Biological Diversity (CBD) requires parties to apply environmental impact assessment (EIA) to projects that potentially negatively impact on biodiversity. As members of the International Association of Impact Assessment, the authors have developed a conceptual framework to integrate biodiversity considerations in EIA. By defining biodiversity in terms of composition, structure, and key processes, and by describing the way in which human activities affect these so-called components of biodiversity, it is possible to assess the potential impacts of human activities on biodiversity. Furthermore, the authors have translated this conceptual framework in generic guidelines for screening and scoping in impact assessment. Countries can use these generic guidelines to further operationalise the framework within the existing national procedures for impact assessment. This paper is fully coherent and partly overlapping with the guidelines recently adopted by the CBD, but differs in the sense that it provides more scientific background and is less policy-oriented.

Keywords: EIA; Biodiversity; Screening; Scoping; CBD

1. Introduction

Article 14 of the Convention on Biological Diversity (CBD) requires parties to apply environmental impact assessment (EIA) to projects that potentially nega-

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tively impact on biodiversity and to apply appropriate procedures for programmes and policies that potentially negatively impact biodiversity. Subsequent decisions of the Conferences of the Parties (COP) to the CBD have recognised that in order to adequately implement this article, further consideration should be given on how biodiversity can be integrated with impact assessments (CBD, 2001).

In order to respond to this request, a conceptual and procedural framework for the integration of biodiversity considerations within national systems for impact assessment has been produced by the authors and discussed among members of the Ecology and Biodiversity section, one of the specialised member forums of the International Association for Impact Assessment (IAIA) (Slootweg and Kolhoff, 2001). The framework concentrates on the screening and scoping steps for project-level EIA. This framework provided a basis for the secretariat of the Convention on Biodiversity to produce, in close collaboration with the authors, draft guidelines for incorporating biodiversity-related issues into environmental impact assessment legislation and/or processes and in strategic environmental assessment. The 6th Conference of Parties of the CBD endorsed these draft guidelines (decision VI/7) and urged parties, other governments, and organisations to apply the guidelines (CBD, 2002). Two other biodiversity conventions have included the guidelines (Ramsar Wetland Convention by Resolution VIII.9) or have referred to the CBD guidelines (Convention on Migratory Species by Resolution 7.2).

This paper is completely coherent with the CBD guidelines, but the focus is somewhat different. While the CBD guidelines focus on procedures and policies, this paper provides a description of the theoretical concepts behind the COP decision VI/7 and provides further details on the proposed procedural steps for screening and scoping in project-level environmental impact assessment. The reason to first elaborate on the screening and scoping stages of the EIA process is that these steps define the whole EIA process; the decision on further study is taken with a screening decision and the issues to be studied in EIA are identified in the scoping stage. As requested by CBD decision VI/7, further development and refinement of the guidelines are needed to incorporate all stages of the environmental impact assessment and strategic environmental assessment processes.

Slootweg et al. (2001) describe a comprehensive conceptual framework, designed to provide an understanding of the causal chains by which activities lead to impacts, through biophysical and social pathways. The framework is intended to accommodate all conceivable biophysical and social impacts. In this document, the framework has been elaborated in detail for the identification of biodiversity-related impacts. The use of an all-encompassing framework is deliberate, so as to make sure that biodiversity is an integral part of existing impact assessment procedures and legislation. In other words, no new instrument nor procedure is proposed; the proposed approach can be accommodated with existing procedures.

Treweek (1999) indicated that the inconsistency of methodologies and of reporting on methodologies and results has, among other reasons, seriously hampered the accumulation of one body of relevant experience and knowledge in the prediction of impacts on biodiversity. It is hoped that this framework can provide a tool to promote greater consistency in addressing issues related to biodiversity in EIA. This paper is addressing the scientific and impact assessment communities in countries that intend to improve the performance of their EIA instrument with respect to biodiversity. The paper does not provide a fixed procedure or predictive model; moreover, it provides a way of thinking on how biodiversity can be better embedded in existing EIA systems. As each country has its own biological, social, legal, and administrative characteristics, it is up to the countries to take up the challenge to adapt their EIA systems for better conservation and use of biodiversity.

2. The general framework

In Fig. 1, the general framework, as described by Slootweg et al. (2001), is presented. The framework provides a sequence of steps to determine the impacts that may result from a (proposed) activity. The starting point of analysis is an activity that can be a biophysical or a social intervention. (Bear in mind that a proposed project can be composed of a large number of different activities.) The steps that follow are described below:

(A) Biophysical interventions lead to biophysical changes being defined as changes in the characteristics of the recipient media soil, water, air, flora, and fauna (e.g., a dam changes river hydrology).
(B) Each direct biophysical change can result in a chain of second-order and higher-order biophysical changes (e.g., a reduction in river flow will result in

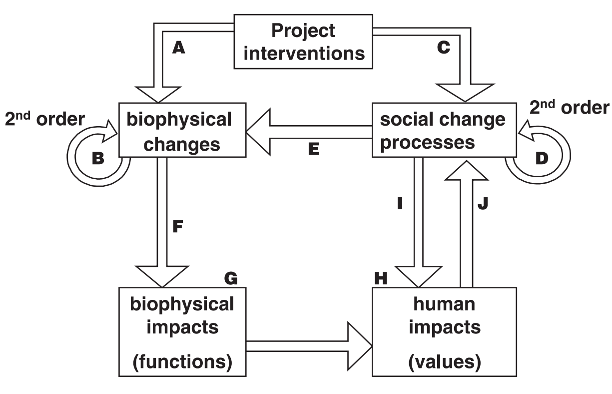

Fig. 1. General framework (adapted from Slootweg et al., 2001).

reduced submersion of downstream floodplains, which may in turn influence the recharge of groundwater aquifers under these plains, etc.).

(C) Projects can also carry out social[2] interventions that lead to social change processes being defined as changes in the characteristics of social components (individuals, families, functional groups, or a society as a whole); the nature of these characteristics can be demographic, economic, socio-cultural, emancipatory, institutional, land use, etc. (e.g., the construction and operation of a dam can attract migrant workers).

(D) Higher-order social change processes. Each direct social change process can lead to second-order and higher-order social change processes (e.g., in-migration of foreign workers may lead to segregation, which in turn may lead to marginalisation).

(E) Social change processes lead to biophysical changes. A change in the social characteristics of a community can lead to biophysical changes (e.g., population growth can lead to occupation and conversion of new land).

(F) Most biophysical changes will only affect the area where the activity is carried out; these are so-called onsite changes. However, a number of biophysical changes will have a wider area of influence and will cause offsite changes. A knowledgeable expert will be capable of determining the geographical range of influence of these changes. Knowing the potential area of influence, one can identify the ecosystems and land-use types that lie within the boundaries of the area of influence. Different biophysical changes can have different areas of influence; for each expected biophysical change, one has to define the area of influence and determine the ecosystems and land-use types that may potentially be influenced.

(G) Each ecosystem or land-use type provides a unique set of functions that are valued by society; these functions are often referred to as goods and services provided by nature. Under the influence of biophysical changes, these functions may change. Impacts are defined as the changes in the quality or quantity of the goods and services (= functions) provided by an ecosystem or land-use type (including both biotic and abiotic environment).[3]

(H) A change in the functions provided by the natural environment will lead to a change in their value for human society. The function concept is principally anthropocentric, translating nature into functions for human society. Society puts a value on these functions. Biodiversity provides functions that are converted into use and nonuse values to human society. Values can be expressed in economic, social, or ecological terms.

[2] The term "social" is used in the broad sense, thus also including cultural, economic, and institutional aspects (for further details, see van Schooten et al., in press; Vanclay, 2001).

[3] We use the functions of nature concept as described by de Groot (1992), distinguishing four categories of functions: production, processing and regulation, carrier, and significance functions. More on this in relation to the presented framework is provided by Slootweg et al. (2001).

(I) Social change processes cause social impacts (not within the scope of this paper; see van Schooten et al., 2003).
(J) As human beings or society as a whole are able to respond to impacts, the experience of social impacts, in some cases, leads to so-called invoked social changes processes (e.g., people may decide to move elsewhere after the emergence of social tensions, or when productivity of natural resources diminishes).

In the framework, a rigid distinction is being made between "changes" or "change processes" and "impacts." Biophysical changes and social change processes are defined as being independent of the context in which they occur. If an intervention is known to cause certain changes, these changes will always occur if a suitable recipient is present. Magnitude and direction of change are determined by the combined characteristics of the intervention and the recipient involved. Biophysical changes and social change processes can—if the state of technology allows so—be predicted, measured, and quantified by external experts.

Contrary to changes or change processes, impacts (biophysical as well as social) are considered to be context-dependent. Functions of the natural environment are determined by the type of ecosystem or land-use type, where biophysical changes occur, and by the level of recognition of these functions by society (i.e., their occurrence depends on the context in which one works). One has to know the exact nature of the ecosystem or land-use type where biophysical changes occur and one has to know the use that society makes use of these functions (including people's perception of these functions). Outside experts will be capable of defining most functions of known ecosystems or land-use types. Yet, whether these functions are actually valued by society, and thus should be included in EIA studies, is completely dependent on the societal context. This relates to the norms and values system of a society, represented by its laws and regulations (customary rules or formalised legislation).[4]

The important consequence of this notion of context dependency is that impacts cannot be determined by external experts only, but that stakeholders have to be consulted. For the purpose of conservation of biodiversity, this is of extreme importance because if one does not know the perception of biodiversity among a society, it will be very difficult to take into account and explain matters related to nature conservation in EIA studies and, even more difficult so, during project implementation. Furthermore, groups in society may adhere different values to biodiversity, which potentially leads to conflicting interests. EIA is the tool

[4] Society, of course, is not a single entity. Perceptions and values will differ at different levels of society (e.g., the local, regional, national, and international society). Similarly, differences will exist between groups within society. Special reference should be made to indigenous people whose traditional uses and knowledge of biodiversity are referred to in Article 8(j) of the biodiversity convention. Stakeholder representation in the EIA process has to guarantee that these aspects are taken on board. Legal mechanisms have to guarantee this representation.

designed to provide insight in these potential conflicts in an early stage, so that alternative, mitigative, or compensatory measures can be taken.

3. The scope of biodiversity

A fundamental question is: "What exactly is considered to be biodiversity and, consequently, what needs to be put under the heading biodiversity in EIA procedures and studies?" The definition of the CBD states, "Biological diversity means the variability among living organisms from all sources, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems." For the operationalisation of this definition in the context of EIA, it will be necessary to concentrate on functions for the maintenance of biodiversity and the nonuse values derived from these, and the impacts of biophysical and social change on these functions and values.

However, Article 10 of the convention, referring to sustainable use of components of biodiversity, would require a much wider view on biodiversity. In order to "protect and encourage customary use of biological resources in accordance with traditional cultural practises that are compatible with conservation or sustainable use requirements," many of the functions of nature to which society assigns use values would fall under the notion of biodiversity. Examples of such functions are:

(i) production functions that relate to harvestable products such as fish, wood, bush meat, medicinal plants, wild fruits and nuts, etc.
(ii) processing and regulation functions that depend on, for example, organisms that act as pollinators; biological control organisms in fruit plantations; the decomposition of organic material/waste by many species of relatively unknown invertebrates; etc.
(iii) carrying functions provided by local ecosystems that determine the quality, health, and safety of the environment in which people live (mangroves protect coastal villages against storm surges, wetlands provide clean water, etc.)
(iv) significant functions such as nature-based leisure and tourism activities, or sites of religious or scientific interest, etc.

With respect to possible impacts on biodiversity, two questions thus have to be answered in EIA studies:

- For nonuse values related to biodiversity: Does the intended activity affect the physical environment in such a manner or cause such biological losses that it influences the chance of extinction of cultivars, varieties, and populations of species, or that it changes the quality of habitats or ecosystems?

- For use values derived from biodiversity-related functions:
  - For production functions: Does the intended activity surpass the maximal sustainable yield of a resource, population, or ecosystem?
  - For processing and regulation functions, carrying functions, and signification functions: Does the intended activity surpass the maximum allowable level of disturbance?

4. How to define impacts on biodiversity

Above, it has been shown how a proposed activity leads to a number of biophysical changes (either directly, or through social change processes). It has furthermore been demonstrated that, having identified these changes, one can define the geographical area where these changes occur, and thus one can make an inventory of types of landscapes (natural and seminatural ecosystems and land-use types) that could be influenced by the proposed activity. Having identified the landscapes, the last step that remains is to describe these landscapes and identify the possible impacts on biodiversity in these landscapes.[5]

The practical problems in describing the biodiversity of an area may be overwhelming, in many cases due to lack of data, or else due to the sheer amount of data and the problem of selecting what is relevant information. However, the approach, as presented here, allows for the identification of serious threats to the maintenance and use of biodiversity, even if one is not capable of exactly describing this diversity at all three levels (genetic, species, and ecosystems). Ecological knowledge has progressed far enough to make certain predictions, based on generally applicable knowledge and rules of thumb.

In order to be able to describe potential impacts on biodiversity, one other concept of diversity has to be introduced—the components of biodiversity. Biophysical changes may affect diversity at genetic, species, or ecosystem level. The problem, of course, is to identify the mechanism through which the maintenance of diversity works, and how biophysical changes can be of influence. Based on various sources in the scientific literature, it is argued here that three essential features of biodiversity provide this "missing link." The approach is based on Noss' (1990) classification of biodiversity, elaborated by Le Maitre and Gelderblom (1998), and further operationalised by Koning and Slootweg (unpublished document). Each of the three levels of diversity (i.e., genetic, species, and ecosystem level) can be characterised and described

[5] The term "landscape," as it is used here, does not refer to a fourth level of biodiversity as introduced by landscape ecology. In this paper, the three levels defined by the CBD are used: genetic, species, and ecosystem. Moreover, it is a term combining natural ecosystems and heavily influenced types of land use.

in detail by answering three questions that refer to the components of biodiversity.

- What is there (refers to the composition)?

When describing the composition of biodiversity of an area, one describes flora and fauna and how abundant it is. In the general practice of EIA nowadays, the species composition of an area is often the only aspect that is considered. In a good analysis, composition also applies to ecosystem composition (types of ecosystems in the area) and when dealing with agro-biodiversity with genetic composition (availability of local varieties of cultivated plants and animals).

- How is it organised in space and time (refers to structure)?

The structure describes how the elements of biodiversity are organised in time and space. Three types of structure can be distinguished.
Horizontal structure: spatial distribution of ecosystems, species, or genetic variability (e.g., species and ecosystems may have a patchy distribution or can follow gradient situations that create gradual changes from one ecosystem into another).
Vertical structure: the vertical structure is often related to strong vertical differentiation of physical parameters such as penetration of light, local temperature (thermocline), and oxygen (stratification) (e.g., forests are vertically layered, each layer having its own communities of plants and animals). Plant and animal communities in coastal zones vary distinctly with depth.
Temporal structure: many species and ecosystems are adapted to cyclic phenomena such as seasonality (e.g., summer–winter, dry–wet season in relation to breeding, flowering, migration, hibernation, etc.), tidal rhythm (mangroves, mud flats), diurnal rhythm (nocturnal animals), or lunar cycles (Chaoborus mosquitoes appearing at full moon). These phenomena can be regular (all of the above examples) or irregular, such as adaptations to prolonged droughts or irregular fires.

- What process(es) is (are) of key importance for its creation and maintenance (refers to physical, biological, or biophysical processes, i.e., key processes)?

A relatively small set of plant, animal, and abiotic processes structures ecosystems across scales of time and space. A key process is defined as a process that plays a dominant role in structuring or maintaining ecological units (population, habitat, community, ecosystem, and landscape) and/or in structuring or maintaining processes between units. Key processes may be of a completely abiotic nature, biotic nature, or a mix of both (e.g., plants and animals colonise newly created habitats and live in so-called pioneer communities that are fully dominated by abiotic factors: temperature, rainfall, soil quality, tidal rhythm, etc.); in contrast, climax situations create and regulate their own environment, and biotic processes dominate (e.g., seed dispersal in pioneer vegetation occurs predominantly by wind or water; in tropical rainforests, it occurs by birds, bats, and terrestrial mammals). Similarly, microclimatic conditions and nutrient supply in pioneer vegetations are dominated by physical processes, while rainforests maintain their own microclimate and nutrient cycles. Other examples of key processes are: natural fires and grazing, which are key processes in the maintenance of savannah systems; and yearly floods, which define floodplain ecosystems. In areas with a long history of human interference such as traditional agricultural practises, man-driven processes responsible for maintaining sometimes highly biodiverse landscapes can also be recognised. Examples are alpine pastures, heathlands, etc.

If one knows the biophysical changes that can be expected from a proposed activity and their area of influence (through technical studies, computer simulation, etc.), an experienced ecologist can determine how these biophysical changes will interact with the components of diversity and how this may affect the ecosystem or land-use types within the area influenced by the biophysical change. Due to the high interconnectedness within and between ecosystems, most biophysical changes will result in a cascade-like chain of events. Therefore, it is important to identify the first point where such a chain of events starts. Box 1 provides some examples.

Box 1. Some examples of how human interventions interact with components of biodiversity

- Example 1—composition and spatial structure.

Selective logging in primary forest will influence the species composition of the forest ecosystem and will change the spatial distribution (structure) of the logged species (for reasons of simplicity of the example, the direct damage being done by falling trees and the logistics of logging is not taken into account).

- Example 2—spatial structure.

New line infrastructures such as roads and railways cut through existing ecosystems. For many invertebrates and smaller vertebrates, this implies being split up into two reproductively isolated populations. If the original ecosystem was small, the splitting up may result in the creation of two populations that both are under the minimal viable population threshold, will suffer from genetic erosion, and, in the end, will disappear. In turn, the disappearance of one or a few species will cause other biodiversity-related impacts on the ecosystem level, but the initiator changed the spatial structure of the populations and its effect at the genetic level.

- Example 3—temporal structure.

  Proposed dredging activities in a wetland area coincided with the reproductive season for marine bivalves of economic (fisheries) and ecological (food for shorebirds) importance. The turbidity caused by the dredging would cause massive death of young bivalves. Rescheduling of the dredging activities to a later season was enough to avoid great ecological and economic damage.
- Example 4—key process (abiotic).

  The damming of a river results in reduced discharge of sediments in the river's estuary. The sediment balance in the estuary is upset, causing massive erosion of the mangrove ecosystem, in turn reducing the numbers of fish and shellfish that breed in the mangroves, and thus decreasing the numbers of waderbirds that prey upon these organisms, etc. The physical change of reduced sediment discharge in the estuary affected the key process of maintaining a delicate balance in sediment deposition and removal in an estuarine mangrove ecosystem.
- Example 5—key process (biotic).

  A man-made wetland in the Netherlands has, unintendedly, become a Ramsar site of international importance due to the presence of tens of thousands of wintering geese that have stopped the succession of wet reedlands into dry shrubland. By intensive grazing, the shallow open water did not get a chance to grow over and peat formation largely stopped. The intended conversion of the area into a business park has been cancelled and it has become a national reserve. (The intended biophysical change, creation of new land, was effectively stopped by geese, thus creating a new ecosystem due to the introduction of a key structuring process.)

The examples in Box 1 show that it is possible to make statements about possible impacts on biodiversity without detailed knowledge of the species composition and abundance in the ecosystems. After having established the possible impact mechanisms, one is better able to define exactly the research questions that need to be dealt with in an EIA study.

5. Applying the concepts to practise: screening

Screening is intended to determine which proposed new projects need further environmental consideration, to exclude those unlikely to have harmful environmental impacts, and to indicate the level of environmental appraisal that a project will require. Information required for screening should be available in the submitted project description; lacking or additional information may be obtained from the proponent or by a field visit.

Considering the dual objective of the CBD on conservation and sustainable use of biodiversity, two fundamental questions need to be answered in an EIA study:

- Does the intended activity affect the physical environment in such a manner, or cause such biological losses that it influences the chance of extinction of cultivars, varieties, populations of species, or the chance of loss of habitats or ecosystems (i.e., leading to the loss of biodiversity—issues related to the conservation of biodiversity)?
- Does the intended activity surpass the maximal sustainable yield or the maximum allowable disturbance level of a resource, population, or ecosystem (i.e., leading to a reduction or loss of use functions derived from biodiversity—issues related to sustainable use of biodiversity)?

The two questions above have to be further elaborated on the three levels of biodiversity (genetic, species, and ecosystem diversity), and qualitative or quantitative criteria are needed for decision making. To facilitate the development of criteria, the two questions above have been expanded for the three levels of diversity. This results in a set of questions that realistically covers all relevant aspects of biodiversity at the screening stage (adapted from Kolhoff, 2000).

5.1. Genetic diversity

Genetic diversity refers to both natural diversity and diversity in agricultural varieties created by human activities. As agriculture is a totally controlled activity, it can be expected that the potential loss of traditional/local varieties and breeds can simply be determined on the basis of a project description. In this case, it makes no sense to make a distinction between impacts on diversity or impacts on sustainable use, since agro-biodiversity inherently covers both issues simultaneously.

The pertinent screening question with respect to agro-biodiversity thus is:

I. Does the intended activity cause a local loss of varieties/cultivars/breeds of cultivated plants and/or domesticated animals?

The potential loss of natural genetic diversity (genetic erosion) is extremely difficult to determine and it does not provide any practical criteria to come to a screening decision. The issue probably only comes up when dealing with highly threatened, legally protected species, which are limited in numbers and/or have highly separated populations (rhino's, tigers, whales, etc.), or when complete ecosystems become separated and the risk of genetic erosion applies to many species (the reason to construct so-called ecoducts across major line infrastructure). These issues are dealt with at species or ecosystem level. The introduction of genetically modified organisms is a totally new and rapidly developing theme.

Usually this is dealt with under the heading of introduction of exotic species, thus at species level.

5.2. Species diversity

For conservation and sustainable use of biodiversity at species level, the following pertinent questions should be answered at the screening stage:

II. Does the intended activity cause a loss of a population of a species?
III. Does the intended activity affect the sustainable use of a population of a species?

The definition of the level at which "population" is to be defined fully depends on the screening criteria a country or organisation uses. For example, certain plant species are considered to be "rare" in the Netherlands, simply because only some fringes of the highlands to which these species belong can be found in the country. From a European perspective, these species are relatively common. Yet, the government considers these species to be valuable and, within the Dutch territory, the few populations should be maintained. The conservation status of a species thus can differ, depending on perspective: It can be assessed within the boundaries of a country (for legal protection), or can be assessed globally from a biologists' perspective (e.g., see the IUCN, 2001 red list of threatened species).

5.3. Ecosystem diversity

At the ecosystem level of biodiversity, the following pertinent questions should be answered at the screening stage:

IV. Does the intended activity lead to serious damage or total loss of (an) ecosystem(s) or land-use type(s), thus leading to a loss of ecosystem diversity?
V. Does the intended activity affect the sustainable exploitation of (an) ecosystem(s) or land-use type(s) by humans in such manner that the exploitation becomes destructive or nonsustainable?

5.4. Translate screening questions into criteria

For each of questions I–V, practical criteria need to be developed. The presented conceptual framework can be used for the identification of screening criteria. Very often, criteria relate to the biophysical changes that result from an activity. For example, standards for water quality apply to all activities that produce waste water effluent, and usually indicate a maximally accepted level of pollution. The problem with, for example, water quality standards is that they are designed for a limited number of functions of water (i.e., water for human use:

household supply or recreational activities). The criteria have not been designed to consider other functions such as maintenance of biodiversity.

By going stepwise through the framework for different categories of activities and describing their potential impacts on biodiversity through changes in the biophysical environment, it is possible to identify criteria and norms relevant to biodiversity (see Fig. 1). In this paper, we provide pathways of thinking for the identification and technical design of sets of criteria; the weighting process that results in norms and threshold values is a political process of which the outcome may vary for countries and (ideally) even for ecosystems.

5.4.1. Interventions and biophysical changes

Projects involve biophysical and social interventions. These will lead to direct biophysical and social changes, which in turn may lead to higher-order changes. The description of activities and the resulting direct changes would take into account characteristics such as type or nature of activity, magnitude, extent/location, timing, duration, reversibility/irreversibility, likelihood, and significance. Furthermore, good technical design not only takes into account the direct effects, but will also look for indirect effects (e.g., the indirect biophysical consequences of social changes such as relocation of people, or the planned influx of migrant workers needing housing facilities; cumulative and synergistic effects and possibly residual effects if the project document already includes proposed mitigation measures on some of the interventions).

5.4.2. Area of influence

If one knows the biophysical changes that will result from the proposed activity and if the influence of these changes can be modelled or predicted, the area of influence can be determined.

5.4.3. Ecosystems and land-use types under influence and expected impacts on biodiversity

Since the area of influence of the proposed activity is known, the influenced land-use types or ecosystems can be determined. Subsequently, the impacts on biodiversity can be determined.

Having determined (categories of) activities, biophysical changes, area of influence, and impacts on biodiversity, now the best possible screening criteria have to be determined with unequivocal decision rules. This is a process in which scientists, responsible government agencies, and political decision makers all have an important say. The criteria should be scientifically valid, applicable to day-to-day EIA reality, and provide sound information for decision making.

Examples of different types of screening criteria are:

- Activities: Magnitude of the activity, surface area occupied, tonnage of produce, amounts or types of raw materials used, use of specific technology, introduction of species, etc.

- Biophysical changes: Level of air emissions or noise, maximum allowable change in water quality, etc.
- Area of influence: Urban and rural planning schemes or zoning regulations can provide a good reference for screening of projects. It provides a legal basis for restrictions related to geographically known areas [in many cases related to specific types of activities, or types of influence (through biophysical changes) that activities exert on designated areas].
- Ecosystems or land-use types: For specified types of land-use or ecosystems, criteria can be designed; these may also relate to elements of these such as protected species known to occur in certain ecosystems, or landscape elements in certain land-use types. A spatial scale of reference should be set (e.g., provincial, regional, etc.), against which to measure the significance of the impact (i.e., of the loss of ecosystem diversity). This is especially crucial for question V on sustainable exploitation. The word "sustainable" becomes meaningful only in relation to a specific scale of analysis.

Box 2 provides a generic set of screening criteria, representing a mix of the categories above.

Box 2. A suggested set of screening criteria to be elaborated on country level. It only deals with biodiversity criteria and thus is an add-on to already existing screening criteria (reproduced from Slootweg and Kolhoff, 2001; CBD, 2002)

Category A: Environmental impact assessment mandatory

Only in this case, criteria can be based on formal legal backing such as:

- National legislation (e.g., in case of impact on protected species and protected areas)
- International conventions such as CITES, the Convention on Biological Diversity, Ramsar Convention on Wetlands, etc.
- Directives from supranational bodies, such as the European Union directive 92/43/EEC of May 21, 1992 on conservation of natural habitats and of wild fauna and flora, and directive 79/409/EEC on the conservation of wild birds.

Indicative list of activities for which an environmental impact assessment could be mandatory:

(a) **At genetic level:**
- Directly or indirectly cause a local loss of legally protected varieties/cultivars/breeds of cultivated plants and/or domesticated animals and

their relatives, genes, or genomes of social, scientific, and economic importance [e.g., by introducing living modified organisms (LMOs) that can transfer transgenes to legally protected varieties/cultivars/breeds of cultivated plants and/or domesticated animals and their relatives].

(b) **At species level:**

- Directly affect legally protected species (e.g., by extractive, polluting, or other disturbing activities);
- Indirectly affect legally protected species (e.g., by reducing its habitat; altering its habitat in such a manner that its survival is threatened; introducing predators, competitors, or parasites of protected species, alien species, or GMOs);
- Directly or indirectly affect all of the above for cases that are important in respect of, for example, stopover areas for migratory birds, breeding grounds of migratory fish, and commercial trade in species protected by CITES;
- Directly or indirectly affect nonlegally protected, threatened species.

(c) **At ecosystem level:**

- Are located in legally protected areas;
- Are located in the vicinity of legally protected areas;
- Have direct influence on legally protected areas (e.g., by emissions into the area, diversion of surface water that flows through the area, extraction of groundwater in a shared aquifer, disturbance by noise or lights, pollution through air).

Category B: The need for, or the level of, environmental impact assessment is to be determined

In cases where there is no legal basis to require an environmental impact assessment, one can suspect that the proposed activity may have a significant impact on biological diversity, or that a limited study is needed to solve uncertainties or design limited mitigation measures. This category covers the frequently referred to but difficult-to-use concept of "sensitive areas." As long as so-called sensitive areas do not have any legal protected status, it is difficult to use the concept in practice, so a more practical alternative is provided.

The following categories of criteria point towards possible impacts on biological diversity, and further attention is thus required:

(a) **Activities in, or in the vicinity of, or with influence on, areas with legal status having a probable link to biological diversity but not legally protecting biological diversity** (e.g., a Ramsar site has the official recognition of having internationally important wetland values, but this recognition does not automatically imply legal protection of biological diversity in these wetlands). Other examples include areas allocated to indigenous and local communities, extractive reserves, landscape preservation areas, sites covered by international treaties or conventions for preservation of natural and/or cultural heritage such as the UNESCO biosphere reserves and World Heritage Sites.

(b) **Impacts on biological diversity possible or likely, but the environmental impact assessment is not necessarily triggered by law.**

(i) **At genetic level:**

- Replacing agricultural, forestry, or fishery varieties, or breeds by new varieties, including the introduction of LMOs.

(ii) **At species level:**

- All introductions of nonindigenous species;
- All activities that directly or indirectly affect sensitive or threatened species if or in case these species are not yet protected (good reference for threatened species is provided by the IUCN red lists); sensitive species may be endemic, umbrella species, species at the edge of their range, or with restricted distributions, rapidly declining species. Particular attention should be given to species that are important in local livelihoods and cultures;
- All extractive activities related to the direct exploitation of species [fisheries, forestry, hunting, collection of plants (including living botanical and zoological resources), etc.];
- All activities leading to reproductive isolation of populations of species (such as line infrastructure).

(iii) **At the ecosystem level:**

- All extractive activities related to the use of resources on which biological diversity depends (exploitation of surface and ground-water, open pit mining of soil components such as clay, sand, gravel, etc.);
- All activities involving the clearing or flooding of land;
- All activities leading to pollution of the environment;
- Activities leading to the displacement of people;
- All activities leading to reproductive isolation of ecosystems;
- All activities that significantly affect ecosystem functions that represent values for society. Some of these functions depend on relatively neglected taxa;
- All activities in areas of known importance for biological diversity, such as areas containing high diversity (hot spots), large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural, or scientific importance; or which are representative, unique (e.g., where rare or sensitive species occur), or associated with key evolutionary or other biological processes.

Category C: No environmental impact assessment required

Activities that are not covered by one of the categories A or B, or are designated as category C after initial environmental examination. The generic nature of these guidelines does not allow for the positive identification of types of activities or areas where environmental impact assessment from a biodiversity perspective is not needed. At country level, however, it will be possible to indicate geographical areas where biological diversity considerations do not play a role of importance and, conversely, areas where they do play an important role (biodiversity-sensitive areas).

6. Applying the concept to practise: scoping

Scoping is the process aimed at determining the kind of information that should be obtained in an EIA study. Scoping enables the competent authority:

- to guide the study team on significant issues and alternatives to be assessed, how they should be examined (methods of prediction and analysis, depth of analysis), and according to which guidelines and criteria;
- to provide an opportunity for stakeholders to have their interests taken into account in the EIA;
- to ensure that the resulting EIS is useful to the decision maker and is understandable to the public.

The final result of scoping are terms of reference (sometimes referred to as guidelines) for the EIA study. During the scoping phase, promising alternatives can be identified, to be studied in more detail during the EIA study.

As Treweek (2000) pointed out, in situations where biodiversity information is lacking, terms of reference for EIA are more likely to omit biodiversity considerations. There is an obvious need for a scoping procedure that accommodates uncertainties and lack of data. This section presents a highly structured approach on the most relevant issues regarding biodiversity during a scoping process. The structure is made systematic in order to provide maximal transparency on the issues at stake in the negotiation process, something a scoping process needs to be.

During the screening phase, there were clear indications that triggered the need for an EIA. These indications pointed towards valuable genetic resources, or protected or threatened species or ecosystems that might suffer significant damage. By going stepwise through the conceptual framework again, the relevant issues to be studied can be identified. The combined knowledge on the components of biodiversity that will be altered (composition, structure or key processes) and the level of biodiversity needing attention (genetic, species, ecosystem) leads to a limitation of issues requiring in-depth study; these should be highlighted in the terms of reference for the EIA study. The list of steps is designed for iterative use, first for qualitative identification of impacts then to assess an order of magnitude of impacts, and during the EIA study itself for quantitative analysis.

The approach is based on the belief that ecological knowledge has progressed enough to be able to make good qualitative judgement on the influence of biophysical changes on ecosystems, even if the exact species composition and abundance or the interspecific and intraspecific relations within the system are not fully known. An experienced ecologist will be able to make comparative statements on the magnitude of impacts when comparing alternative project options, and thus provide relevant information on the expected impacts on biodiversity, without necessarily having to go into details (for which often the means are lacking in the EIA process).

The expected impacts of the proposed activity, including identified alternatives, should be compared with the autonomous development (what will happen with biodiversity over time if the project is not implemented?). The autonomous development is often referred to as the zero alternative (or the "do-nothing" alternative). There should be awareness that doing nothing may, in some cases, also have significant effects on biodiversity, sometimes even worse than the impacts of the proposed activity (e.g., projects counteracting degradation processes).

Another important feature of comparing alternatives is that it often is not necessary to study all relevant issues. Issues that do not have any distinctive value for comparing need not be studied for each alternative. Similarly, if one possible impact caused by one of the alternatives creates a legal blockage (e.g., impacts on a strictly protected area), there appears to be no need to study further impacts for this alternative.

After all, the main challenge with good scoping is to provide sufficient information for informed decision making (as little information as necessary).

The following sequence provides an iterative mechanism for scoping, impact assessment, and consideration of mitigation measures, which should be informed by existing information and the available knowledge among stakeholders (between parentheses, a reference to the steps in Fig. 1):

(a) Describe the type of project, its nature, magnitude, location, timing, duration and frequency.
(b) Describe the expected biophysical changes in soil, water, air, flora and fauna (A and B).
(c) Describe biophysical changes that result from social change processes as a result of the proposed project (C–E).
(d) Determine the spatial and temporal scale of influence of each biophysical change (F).
(e) Describe ecosystems and land-use types potentially influenced by the biophysical changes identified (F).

Table 1
Issues for scoping on biodiversity

		Components of biological diversity			
		Composition	Structure (temporal)	Structure (spatial: horizontal and vertical)	Key processes
Levels of biological diversity	Genetic diversity	• Minimal viable population (avoid reduction by inbreeding/gene erosion) • Local cultivars • Genetically modified organisms	• Cycles with high and low genetic diversity within a population	• Dispersal of natural genetic variability • Dispersal of agricultural cultivars	• Exchange of genetic material between populations (gene flow) • Mutagenic influences • Intraspecific competition
	Species diversity	• Species composition, rarity/abundance, endemism/exotics • Population size • Known key species (essential role) • Conservation status	• Seasonal, lunar, tidal, diurnal rhythms (migration, breeding, flowering, leaf development, etc.)	• Minimal areas for species to survive • Essential areas (stepping stones) for migrating species • Niche requirements within ecosystem (substrate preference, layer within ecosystem	• Regulation mechanisms such as predation, herbivory, parasitism, fertility, mortality, growth rate, reproductive strategy
	Ecosystem diversity	• Types and surface area of eco(sub)systems • Uniqueness/abundance • Succession stadium, existing disturbances and trends (=autonomous development)	• Adaptations to/dependency of regular rhythms: seasonal • Adaptations to/dependency of irregular events: droughts, floods, frost, fire, wind	• Spatial relations between landscape elements (local and remote) • Spatial distribution (continuous or discontinuous/ patchy) • Minimal area for ecosystem to survive • Vertical structure (layered, horizontal, stratified)	• Structuring process(es) of key importance for the maintenance of the ecosystem itself or for other ecosystems (see Table 2)

Table 2
Examples of key processes in the formation and/or maintenance of ecosystems (adapted from de Koning and Slootweg, 1999, unpublished)

Key ecological processes	Relevant for ecosystems
Soil surface stability and soil processes	Lowland dryland rainforest, montane tropical forest, coniferous montane forest, coastal dunes
Soil erosion patterns due to wind	Coastal dunes, degraded land
Soil erosion patterns due to water	Desert, coastal dunes, degraded land
Erosion patterns of upland area and riverbed	Upper, middle, and lower course of rivers and streams
Erosion patterns of soil and vegetation due to wave action	Rocky coastlines and beaches, freshwater lakes, mangroves, and sea grass beds
Sedimentation patterns	Middle and lower course of rivers, floodplains, estuary, tidal flats, mangrove
Replenishment of sand due to up drift sources	Beaches, tidal flats, mangroves
Topography and elevation due to wind erosion	Desert
Local climate (temperatures) determining plant available moisture	Desert, rocky coastline
Seasonal drought/desiccation patterns determining plant available moisture	Deciduous forest, nonforested mountains, savannah, steppe, desert
Seasonal hydrological situation (evaporation, water quantity, water quality, and current/velocity)	Beach, rivers and streams, freshwater, saline or alkaline lakes, reservoirs
Tidal influence (tidal rhythms, tidal range, and tidal prism)	All coastlines, estuary, lagoon, tidal flat, mangrove, sea grass beds
Permanent waterlogged condition of the soil	Peat swamp
Salinity levels and/or brackish water gradient	Lowland river, saline lakes, estuary, mangrove, sea grass beds, coral reef
Water depth, availability of sunlight, and/or thermocline stability	Freshwater lake and reservoirs, coral reef, coastal sea
Regional groundwater flow and groundwater table (source or sink function of landscape)	Freshwater marsh or swamp, saline or alkaline lakes
Flooding patterns (frequency, duration)	Tropical flooded forest, floodplain, freshwater swamp or marsh, mangrove
Hydrological processes (vertical convection, currents and drifts, transverse circulation)	Coral reef, coastal sea, open (deep) sea
Biological processes in the root system	All dryland forests
Protection of soil humus layer by vegetation cover	Lowland tropical rainforest
Canopy density determining light intensity and humidity	Lowland tropical rainforest, deciduous forest
Plant-dependent animal reproduction	Lowland tropical rainforest
Animal-dependent plant reproduction	Lowland tropical rainforest
Grazing patterns by herbivorous mammals	Savannah, steppe (grasslands), tropical flooded forest, floodplain, freshwater swamps or marsh
Grazing patterns by herbivorous birds	Freshwater lake, floodplain, tidal flat
Grazing patterns by herbivorous fish	Freshwater lake, floodplain
Grazing patterns by herbivorous marine mammals	Seagrass beds
Seed dispersal due to water	Mangrove
Seed dispersal by animals (birds, primates)	Lowland tropical rainforest, tropical flooded forest, freshwater swamp or marsh
Pollination due to environmental factors (e.g. wind)	Deciduous forest, mangrove

Table 2 (*continued*)

Key ecological processes	Relevant for ecosystems
Pollination by animals (insects, birds, mammals)	Lowland tropical rainforest, montane tropical forest, deciduous forest, mangrove
Production of pelagic and benthic organisms	Saline or alkaline lake or marsh, estuary
Primary production by phytoplankton	Saline or alkaline lake or marsh, coastal sea, open sea
Nutrient inflow due to environmental factors (i.e., water runoff, drainage)	Upper and middle course of rivers, freshwater lake, tropical flooded forest, tidal flat, sea grass bed
Nutrient input by animals	
Nutrient cycling due to water movement/rainfall	Nonforested mountains, lagoon
Nutrient cycling due to fire	Savannah, steppe
Nutrient cycling by juvenile fish	Tidal flat, mangrove
Nutrient cycling by arthropods/insects	Lowland tropical rainforest, savannah, steppe
Nutrient cycling by invertebrates (earthworms, bivalves, starfish, crabs, shrimps)	Montane tropical forest, deciduous forest, coniferous montane forest, rocky coastline, lagoons, tidal flat, mangrove, coastal sea, open sea
Nutrient cycling by fungi and bacteria	Deciduous forest, savannah, steppe
Nutrient cycling by filter feeders	Coral reef
Gallery forest structure providing shade and nutrient input	Upper course of river
Disruption of vegetation structure due to fire	Lowland tropical rainforest, montane tropical forest, deciduous forest, savannah, steppe, tropical flooded forest, floodplain
Disruption of vegetation structure due to storms/ hurricanes/cyclones	Lowland tropical rainforest, deciduous forest, coniferous montane forest, (coconut) beaches, mangrove
Disruption of vegetation structure due to wave action	(Coconut) beaches, mangrove
Disruption of vegetation structure due to land slides/mud flows	Montane tropical forest, coniferous montane forest, nonforested mountains
Disruption of vegetation structure by animals (herbivores)	Savannah, range land, sylvi-pastoral associations
Peat building by decaying vegetation (accumulation rates versus decomposition rates)	Peat swamp
Dynamics of sedimentation, accretion, and grazing of the coral skeleton	Coral reefs
Predation of coral polyps by starfish and fish (parrotfish, butterflyfish), and smothering of coral polyps	Coral reefs

(f) Determine for each ecosystem or land-use type if the biophysical changes affect one of the following components of biodiversity: the composition (what is there?), the temporal/spatial structure (how are biodiversity components organised in time and space?), or key processes (how is biodiversity created and/or maintained?) (G).

(g) Identify in consultation with stakeholders the current and potential use functions, nonuse functions, and other longer-term, less tangible benefits of biodiversity provided by the ecosystems or land-use types and determine the values these functions represent for society (G and H).

(h) Determine which of these functions will be significantly affected by the proposed project, taking into account mitigation measures.
(i) For each alternative, define mitigation and/or compensation measures to avoid, minimize, or compensate the expected impacts.
(j) With the help of the biodiversity checklist on scoping (Table 1), determine which issues will provide information relevant to decision making and can realistically be studied.
(k) Provide information on the severity of impacts (i.e., apply weights to the expected impacts for the alternatives considered). Weigh expected impacts to a reference situation (baseline), which may be the existing situation, a historical situation, or an external reference situation.
(l) Identify necessary surveys to gather comprehensive information about the biodiversity in the affected area, where appropriate.

The checklist presented in Table 1 provides an overview of all the aspects of biodiversity that may be of relevance to EIA studies. The table is not intended to expand the required workload, but rather to provide a selection mechanism to determine which issues are most relevant to study.

The scoping steps "a" to "e" have provided information on the type of activities, the biophysical changes that can realistically be expected, the area under the influence of these biophysical changes, and, consequently, the ecosystems and/or land-use types affected. The combination of the information on expected biophysical changes and the affected ecosystems or land-use types provided insight on the affected components of biodiversity and whether these impacts would occur at genetic, species, or ecosystem level. With the help of the checklist, one now can define the issues to be studied at genetic, species, or ecosystem level. Table 1 is an example of what the checklist on scoping could look like. It has to be stressed that this is a first preliminary version; the community of ecologists has to take up the challenge to elaborate on this table for the various biomes in the world. Another main challenge is to describe the structuring process(es) of key importance for the maintenance of an ecosystem. An example of a list of key processes for a number of broadly defined ecosystem is provided in Table 2.

7. Concluding remarks

Both biodiversity and EIA communities are invited to critically review and further develop the approach presented in this document. Some of the proposed concepts and procedures need to be further operationalised in generic form before they can be elaborated at country level. For example, the issues in the checklist for scoping (Table 1) need to be defined in a way that the concepts become readily available to and applicable by the EIA community. The idea is that for each biome of the world, a long list of issues relevant to EIA studies needs to be defined. This long list can be narrowed down at country level to a minimal but comprehensive set of issues that can reasonably be studied in the country for which it has been designed. For each ecosystem, the key processes need to be defined and operationalised.

For the further development of the checklist for scoping, the community of ecologists and biodiversity experts is asked to join the EIA community in an attempt to strike a balance between the scientific rigour that ecologists and biodiversity scientist have to apply to their fields, and the everyday practicability of the approach by EIA practitioners. For this elaboration of the checklist for scoping, some aspects need special attention:

- What is it? Explain the checklist issue for informed but nonspecialist audience.
- Causal relationship with biophysical changes: What biophysical changes typically lead to the need to study a particular issue?
- How can the issue be described? Is it easy or difficult, depending on the kind of setting?
- How relevant is it for EIA? If it is difficult to study, in what special cases should it be included in the terms of reference?
- Provide thresholds or define ranges of acceptable change to determine the relevance of an impact for decision makers.
- Provide indicators for comparison, monitoring, and evaluation.
- What alternatives are there to provide second-best information if resources for study are limited?

The presented conceptual framework and the procedural elaboration for screening and scoping that have been presented in this paper merely provide a first step in a process that should lead to a worldwide recognition of the importance to include biodiversity considerations in decision making, with EIA being an important tool in this respect. The framework has been elaborated as one element of an action programme on biodiversity and impact assessment that is being implemented by the International Association for Impact Assessment. The action programme ultimately aims at assisting countries in developing their own mechanisms to incorporate biodiversity considerations in their impact assessment system. Based on the provided framework, countries can start the development of their own mechanisms. The action programme aims at close collaboration with the CBD. The convention in turn has elaborated the framework into draft guidelines, which have been endorsement by the Conference of Parties in 2002. Furthermore, the convention provides the agenda for the coming years by recommending further development and refinement of the guidelines, particularly to incorporate all stages of the environmental impact assessment (now limited to screening and scoping) and to elaborate the guidelines for application to the strategic environmental assessment process.

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References

CBD. Recommendations adopted by the Subsidiary Body on Scientific, Technical and Technological Advice at its seventh meeting. UNEP/CBD/COP/6/4, 2001 (http://www.biodiv.org/decisions).

CBD. Decisions adopted by the conference of the parties to the Convention on Biological Diversity at its sixth meeting, The Hague, April 7–19, 2002 (http://www.biodiv.org/decisions).

de Groot RS. Functions of nature: evaluation of nature in environmental planning, management and decision making. Groningen, The Netherlands: Wolters-Noordhoff; 1992.

de Koning PC, Slootweg R. Key ecological processes in the assessment of impacts on biodiversity. Leiden: Mekon Ecology; 1999. Unpublished document; available from corresponding author.

IUCN. Red list categories: version 3.1. Prepared by the IUCN Species Survival Commission. Gland, Switzerland, Cambridge, UK; 2001.

Kolhoff A. Biodiversity in EIA—an overview and assessment of the present situation and experiences from the Netherlands. Back to the future. Proceedings of the 20th Annual Meeting of the International Association for Impact Assessment, Hong Kong, June 19–23; 2000.

Le Maitre DC, Gelderblom CM. Biodiversity impact assessment: putting theory into practise. IAIA Paper. New Zealand: Christchurch; April 1998.

Noss RF. Indicators for monitoring biodiversity. Conserv Biol 1990;4:355–64.

Slootweg R, Kolhoff A. Proposed conceptual and procedural framework for the integration of biological diversity considerations with national systems for impact assessment. Report of the Netherlands Commission for EIA; July 2001.

Slootweg R, Vanclay F, van Schooten MLF. Function evaluation as a framework for integrating social and environmental impacts. Impact Assess Proj Apprais 2001;19:19–28.

Treweek J. Ecological impact assessment. London: Blackwell; 1999.

Treweek J. Biodiversity in development. Biodiversity and EIA for development cooperation: workshop conclusions. EC/EU Tropical Biodiversity Advisor's Group (TBAG), EC/ DFID/IUCN; 2000.

Vanclay F. Conceptualising social impacts. Environ Impact Assess Rev 2001;22:1–29.

van Schooten MLF, Vanclay F, Slootweg R. Conceptualising social change processes and social impacts. In: Becker HA, Vanclay F, editors. International handbook of social impact assessment: conceptual and methodological advances. Cheltenham: Edward Elgar; 2003. In press.

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