Chapter 3
The Challenges of Sustainable Development in the Podocarpus-El Cóndor Biosphere Reserve

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3.1 Introduction

Since the publication of the Brundtland Report in 1987 (WCED 1987), sustainable development has been the prime guiding principle for discussing the challenges of human development in view of limited natural resources. Numerous activists and scholars have taken issue during the past two and a half decades with the anthropocentric core of sustainable development, and with its apparently poor capacity to prescribe specific courses of development. Still, the fundamental proposition is as relevant today as ever: any sustainable development must focus on the needs of the current generation without compromising the ability of future generations to fulfil their needs. Science will only be able to contribute directly to this task if it meets the challenges of interdisciplinary collaboration.

From a sustainable development perspective, science has to analyse (1) on which ecosystem states, processes, or structures the ecological services depend that human

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society utilises, (2) which pressures threaten the respective ecosystems and their services, and (3) how the long-term capacity of these ecosystems to provide ecosystem services can be protected and developed (Barkmann et al. 2008). The first point is the main topic of several of the following chapters including Chap. 4, which provides an overview on the ecosystem services investigated by Research Unit RU 816. With regard to pressures (point 2), this book focuses on the conversion of near natural forests to pasture ecosystems (cf. Chap. 15). External atmospheric nutrient inputs and climate change are also considered (Chaps. 11, 23, and 24). Concerning the last point, the research unit addresses several protection options: the conservation of biological diversity by protecting the remaining forests, reforestation and rehabilitation of abandoned pastures, and the general improvement of farm management in order to reduce forest conversion caused by poverty (see Chaps. 22, 26, and Sect. 3.3.2).

After discussing the sustainable development concept (Sect. 3.2), implications for scientific decision-making support at tropicap biodiversity hotspots are derived with reference to the Ecosystem Approach of the Convention on Biological Diversity (CBD) and the Aichi Biodiversity Targets (Sect. 3.3). The chapter closes with two examples of those conservation-development trade-offs that research needs to address to meet the challenges of sustainable development.

3.2 Sustainable Development

In the year 1713 the Chief Mining Officer of Saxony, v. Carlowitz, called for the "greatest art, science and industry" in order to "conserve and produce wood in a way that there be a continuing, stable and sustaining use" (Carlowitz 1713, p. 105; translation jb). But it became more and more apparent to the general public only in the 1960s that many natural resources were being exploited at rates impossible to sustain indefinitely (e.g. Meadows et al. 1972). The well-being or even the existence of humankind appeared to be threatened. By the late 1970s it had become well established that the strain on global natural resources resulted from the combined impacts of a poor majority struggling for a livelihood and an affluent minority consuming a disproportionately large share of these resources (IUCN/WWF/UNEP 1980). Within this strand of the global environment and development discourse, the term sustainable development was coined.

In 1983 the General Assembly of the United Nations adopted the term sustainable development. The UN created a "Special Commission", later known as the World Commission on Environment and Development (WCED) or, simply, the Brundtland Commission (WCED 1987, p. ix; United Nations 2012). It was tasked with firmly establishing the search for a global "environmental perspective" on the international political agenda. The most widely quoted definition of sustainable development is found in the report which WCED published 4 years later (WCED 1987, p. 43):

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Following the Brundtland approach, three essentials of sustainable development should be emphasised (Barkmann 2002):

- orientation towards (basic) human needs,
- environmental equity and justice (intergenerational and international justice), and
- retinity (from Latin *retis*: the net); retinity refers to the complex interaction of the ecological, economic, and social spheres required for responsible decision making (SRU 1994).

The Brundtland approach does recognise absolute limits of development set by the global life support system (WCED 1987, p. 45). Still, WCED points out that there is no single point beyond which ecological disaster is to be expected. Different resources have different limits, and technology and knowledge can extent the limits of the resource base at least at times. Without doubt, the Brundtland definition is a socio-economic and anthropocentric approach—a fact for which it is frequently criticised. There is, however, little debate that prime attention to basic human needs and to environmental justice forms a minimum requirement for any consistent sustainable development paradigm (e.g. Birnbacher 1980; Krebs 1997).

Sustainable development in the WCED sense is often depicted by three overlapping circles (the ecological, economic, and social spheres). This graphical representation suggests equal importance of these three spheres (or "pillars"). However, all goals of sustainable development originate from the social sphere. The environmental as well as the economic limitations and preconditions of human production and consumption are of "only" instrumental value with respect to the satisfaction of basic human needs and the demands of environmental justice.

In order to stress the interrelatedness of the three spheres, the German Advisory Council on the Environment coined the term "retinity" ("Retinität"; SRU 1994). Retinity demands that all conservation and development decisions take the interrelatedness of three spheres into account. The WCED highlights the retinity norm regarding ecological and economic aspects in a subsection on *Merging Environment and Economics in Decision Making* (WCED 1987, p. 62ff.).

Technically speaking, systematic decision making within a sustainable development framework means that multi-dimensional bundles of ultimate and proximate objectives are to be taken into account. The complexity of issues involved in properly assessing alternative courses of action precludes the existence of a simple "blueprint" for sustainable development (WCED 1987, p. 40). In the event of conflict, there is no ecological meta-guideline according to which conflicting objectives, for example biodiversity conservation and utilisation of the economically productive resource base, can be prioritised. The ecosystem service concept as popularised by the Millennium Ecosystem Assessment (MA 2005; see also Chap. 4) provides an analytical basis for *investigating* these conflicts, not for solving them. In this respect, the carrying capacity/ecocapacity approach is too deeply entangled

in a mesh of unresolved social and normative questions as to be a generally applicable, normatively justified guideline (Barkmann et al. 2008).

Its restrictions do not make the sustainable development concept useless. In fact, several authors have pointed out that sustainable development should be interpreted as a *regulative idea* of the discourse on environment and development (cf. Jörissen et al. 1999; Hirsch-Hadorn 1999). Like other regulative ideas such as freedom or justice, sustainable development has a clear normative dimension (basic needs orientation, intergenerational and international justice), and guides the search for human courses of action. If interpreted as a regulative idea, it is evident why a reference to the sustainable development paradigm itself cannot select the "best" option for development or conservation: this must be done by the "regulated" discourse on environment and development.

In combination with the retinity demands of sustainable development, the regulative character of the concept establishes certain information requirements that science needs to respond to. With respect to the situation in the project area of RU 816—i.e. the northern part of the UNESCO Biosphere Reserve Podocarpus-El Cóndor, we turn to an investigation of two exemplary information needs in the second part of the next section.

3.3 Implications for Research in Tropical Biodiversity Hotspots

3.3.1 CBD Ecosystem Approach and Aichi Biodiversity Targets

Accepting the proposition that sustainable development is a regulative idea (see above) has consequences for the way in which applied sciences have to interpret their role. Most fundamentally, applied ecological and socio-economic sciences need to generate and present knowledge in a way that diverse groups of stakeholders can make good use of in decision-making processes. In consequence, applied sciences have to make their expertise "discourse-able" (Barkmann 2001).

In the project area, various land users compete for access to limited natural resources. During the first phase of RU 816 in 2007, the Podocarpus–El Cóndor region was officially recognised by UNESCO as a Biosphere Reserve (BR; Bendix et al. 2010). A BR is a protected area specifically dedicated to the principles of sustainable development. In accordance with UNESCO's Seville Strategy (2012), the *core zone* of the BR is formed by strictly protected Podocarpus National Park. Around this core, several *buffer zones* are located. One of the buffer zones is the protected forest area "Bosque Protector Corazón de Oro" (Fig. 3.1). Between this buffer zone and the national park, a less protected *transition zone* is wedged along the main road from Loja to Zamora.

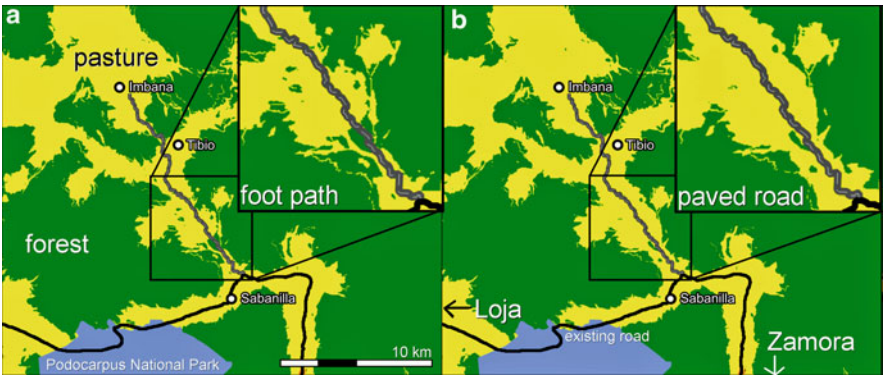

Fig. 3.1 Predicted extent of forest habitat loss if the footpath between Imbana and Sabanilla is replaced by a paved road; the *inset* highlights an example of substantially reduced habitat connectivity between the Sabanilla/Podocarpus (South) and the Yacuambi (Northeast) habitats of the Andean bear (*Tremarctos ornatus*)

Local farmers are interested in the continued or even extended availability of productive pastures (see Chaps. 15 and 26). The urban public is interested in the quality of drinking water (see Chap. 4). National and international conservationists focus on the conservation of biological diversity. Finally, tourists and recreational users are interested in the amenity value of the South Ecuadorian landscape. Principally, all of these land-use interests can be traced to some socially legitimate objective. Thus, references to sustainable development cannot be directly drawn upon to prioritise these interests. Nevertheless, sustainable development as a regulative idea requires that decision making must respect the sustainable development essentials mentioned in Sect. 3.2.

The CBD does not directly refer to sustainable development as a regulative idea. Yet, the twelve Malawi Principles (Hartje et al. 2002; see Table 3.1), on which the CBD Ecosystem Approach is based, provide important guidelines how the sustainable development of tropical biodiversity hotspots should be organised. It is the basic idea of the CBD Ecosystem Approach (CBD 2012a) that biological diversity can only be conserved successfully if the multitude of its interactions with humans is taken into consideration in a balanced manner–as required by the retinity norm.

The Aichi Biodiversity Targets were approved within the legal framework of the CBD in 2010. They combine some of the most important procedural principles of the CBD Ecosystem Approach with quantitative targets for biodiversity protection. For example, Principle 3 demanding management decisions within an "economic context" is now represented by Target 3

> "By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimise or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions" (CBD 2012b).

Table 3.1 Selected principles of the CBD Ecosystem Approach

Number	Principle of the CBD Ecosystem Approach
1	The objectives of management of land, water, and living resources are a matter of social choice
2	Management should be decentralised to the lowest appropriate level—hoping to achieve greater efficiency, effectiveness, and equity
4	There is a need to understand and manage the ecosystem in an economic context because biological diversity is threatened by ecosystem conversion to more intensive land-use systems. Any such ecosystem-management program should (1) reduce market distortions that adversely affect biological diversity, (2) align incentives to promote diversity conservation and sustainable use, and (3) internalise costs and benefits in the given ecosystem to the extent feasible.
5	Ecosystem structure and functioning should be a priority target of the CBD Ecosystem Approach in order to maintain ecosystem services
10	The CBD Ecosystem Approach should seek for an appropriate balance between and strive for an integration of conservation and use of biological diversity
11	The approach should consider all forms of relevant information, including scientific, indigenous and local knowledge, as well as innovations and practices

The principles are partly abbreviated and slightly modified

The fundamental match of a discursive framework for sustainable development and the CBD Ecosystem Approach is exemplified by the first principle of the approach: *The objectives of management of land, water, and living resources are a matter of social choice*. Although more detailed than the essentials of sustainable development, already the CBD Ecosystem Approach's first principle indicates that the fundamental ambiguities of social decision making will remain when it comes to local application. Even though the quantitative nature of the Aichi Biodiversity Targets may suggest otherwise, the described ambiguities also remain unsolved there.

3.3.2 Examples from the Project Area

How should a binding management plan for the BR Podocarpus-El Cóndor be developed? Some of the most severe land-use conflicts in the project area of RU 816 can be expected in the protected forest area Corazón de Oro. According to the Seville Strategy, only "activities compatible with the conservation objectives" may take place here (e.g. environmental education, ecotourism, research) (UNESCO 1996, p. 17). Even in the transition zone, agricultural activities and settlements are only allowed under certain restrictions. In fact, however, a few hundred households have been settling in the Corazón de Oro region for several decades. The inhabitants are predominantly pastoralists. They also have small arable fields or home gardens, and at times extract valuable timber trees from remote parts of the forest (Maza 2011). Thus, a realistic management and development plan for the area cannot consider conservation issues only; it must also account for the existing villages and their

socio-economic development. Any other approach would clearly be against the spirit and the letter of the fundamental documents of sustainable development and their implementation through the CBD.

For example, the inhabitants of the indigenous villages of El Tibio Alto and El Tibio Bajo have access to the main road between Loja and Zamora only via a long footpath. Both villages belong administratively to the province of Zamora-Chinchipe. In consequence, the inhabitants can reach their own provincial capital Zamora faster if they first travel to the capital of adjacent Loja Province than if they go directly to Zamora. Given this obstacle to accessing essential administrative services, the construction of a road from Imbana to Sabanilla, which better connects these remote villages to the network of main roads, has been suggested. However, analyses by project C3.2 of RU 816 suggest that the construction of the road will have substantial negative effects on biodiversity (Eichhorn et al. 2010).

Making information "discourse-able" in the context of this potential sustainable development conflict means that the prospective impacts of road construction have to be analysed with respect to the ecosystem services that main stakeholders care about. Local farming households with a shortage of accessible land or with poor access to markets and public and private services may be interested in knowing how much faster or less expensive they can access land, markets or services. In contrast, conservationists want to know how much forest will be lost and how Andean bear (*Tremarctos ornatus*) populations are affected that inhabit the forests of the region.

In addition to the direct loss of forests, a further expansion of current pasture area is likely as improved road access facilitates the establishment of new pastures, i.e. of additional farms (Eichhorn 2009; Eichhorn et al. 2010). In turn, the road and the new pastures will reduce connectivity between Andean bear habitats along the Yacuambi–Podocarpus–Sabanilla biological corridor, which forms a regional habitat bottleneck (inset in Fig. 3.1). A first quantitative assessment of the trade-offs of road construction concludes that about 600–700 ha of forest may be lost, mainly by conversion to pastures. This equals roughly the habitat size of two adult female bears, i.e. of two *effective individuals*. Also, habitat connectivity will suffer substantially. The smallest distance between disconnected but adjacent main habitat patches of the Andean bear will increase from less than 150 m to more than a critical value of about 1,000 m. On the other hand, the additional pastures may provide livelihood for 30–40 average farm households. Without additional sources of livelihood and at current production technology, income would be close to absolute poverty levels, though (Eichhorn et al. 2010).

The bulk of the pasture area shown in Fig. 3.1 is legally located in the protected "forest" area, and in the—no-agriculture—buffer zone of the BR. From a conservationist point of view, massive reforestation in the buffer zone could be justified. At least, further forest conversion should be stopped. However, the majority of the affected rural population consists of poor smallholders. Any policy measure of the BR management plan that affects their livelihood should be investigated and considered carefully. We explore some of the most important impacts that a ban on further forest conversion in the Corazón de Oro region is likely to engender in

the following paragraphs. An economic analysis of reforestation options is found in Chap. 25.

Specifically, we assume that losses of future farming income by the deforestation ban are offset by Payments for Ecosystem Services (PES). Payments that provide incentives for smallholders to stop deforestation are potentially available from the *Socio-Bosque* program of the Ecuadorian government (Ministerio del Ambiente 2012). Socio-Bosque aims at combining forest conservation with poverty alleviation. Using a typical Socio-Bosque budget, Maza et al. (2011) found that ~36 % of the threatened forest in the research area could be covered by a PES scheme that exactly compensates lost pasture incomes. At the resulting compensation rates, positive effects on poverty alleviation are unlikely in the long run (cf. also Olschewski et al. 2005; Olschewski and Benítez 2005). Only if payments (1) are targeted at those farm households most in need and (2) substantially overcompensating income losses, the income of the poor will rise, and existing economic inequalities be reduced. However, pronounced "pro-poor" PES scheme come at a considerable cost: At a fixed, increased compensation of US \$300 ha^{-1} $year^{-1}$, which would substantially reduce local rural poverty, only 10 % of the threatened forest can be covered by the program.

Ideally, a public debate on the pros and cons of different development and conservation options is initiated using this type of trade-off information (Olschewski et al. 2010). Because of heavily conflicting land-use interests, it is far from sure that a consensus on the implementation of a certain option will be achieved—or its final inclusion in the management plan of the BR will be accomplished. International income transfers are potentially available to facilitate consensus for mega-diverse "hotspots" of biological diversity (Hillmann and Barkmann 2009, Chap. 4). Although purely selfish arguments can and will be put forward in public debate, arguments that can refer to basic needs, or to intergenerational or international justice should be given prime consideration. The same holds for arguments that take all available information into account instead of focussing exclusively on ecological or socio-economic criteria.

For all practical purposes, providing information on conservation-development trade-offs is one of the most useful ways of responding to the information requirements of concerned stakeholders. Gearing the generation of knowledge towards the elucidation of such trade-offs is one way for the ecological as well as the socio-economic sciences to meet their own sustainable development challenges.

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