Transdisciplinary research to promote biodiversity conservation and enhanced management of tropical landscape mosaics

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Abstract

By developing methods and instruments that help to inform and facilitate coherent landscape planning across various spatial scales, research institutions can support decisions by communities, conservation agencies and policy-makers. Ideally, these would help to define management options that integrate biodiversity and livelihoods and promote equitable participation in planning processes. Within a joint 'Biodiversity Platform', the CGIAR (Consultative Group on International Agricultural Research) centres CIFOR and ICRAF aim to better understand biodiversity conservation and sustainable use in mosaic landscapes with intermediate land uses such as utilized forests and agroforests. Inter- or transdisciplinarity is one of the key issues in landscape ecology and management (Wu and Hobbs 2002). This paper reviews historical trends of research on conservation and development and identifies lessons from past attempts to combine biodiversity and livelihood aims in tropical landscapes. Based on recent experiences of integrated research the paper concludes with recommendations for transdisciplinary research in tropical landscape mosaics.

Keywords: Transdisciplinary research, tropical landscape management, biodiversity conservation, landscape mosaics

1. Introduction

Tropical forests are being converted rapidly while socio-economic disparities keep increasing in developing countries. Demographic growth and market demands remain major driving forces of land uses. These are guided locally by livelihood concerns and social organization, and externally by policy decisions by various sectors (Lambin et al. 2003). Many of these countries also contain biodiversity 'hotspots' considered of prime importance for conservation. Nowadays conservation bodies recognize that protected areas need to be managed as a part of their surrounding bio-cultural matrix (IUCN 2003) and connectivity has become a crucial element in conservation planning. While communities may restore very degraded areas to strengthen their own livelihoods, conservation around forest margins remains a complex challenge. In landscape mosaics, reserves can be surrounded by 'wild' remnant fragments as well as intermediate-intensity landuses, such as mixed agroforests and plantations. These can act as 'stepping stones' that are managed and sometimes protected by local people. Still, in developing countries, much work remains to truly integrate livelihoods of rural people into both conservation and landscape planning processes.

2. Methodology

The landscape mosaics approach described in this paper was initiated by a workshop held in Bogor, Indonesia, between 30 scientists from CIFOR and ICRAF (Pfund et al. 2006). It was followed by a systematic literature review. This indicated a lack of true integration of social parameters in landscape-level conservation. For this reason, we interviewed people who have worked on integrated projects in the field. Their stories provide lessons primarily from tropical landscapes. The locations include Sumba island, Jambi province, Tanimbar Island and central

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Sulawesi, all in Indonesia; the Western Ghats, in India; the Western mid-hills of Nepal, Zona da Mata in Brazil and the Loja region of Ecuador (Annex 1). Finally, we have incorporated these lessons with the workshop contributions and the literature review to describe the research approach to be taken by the new CIFOR-ICRAF biodiversity platform.

3. From National Parks to landscape mosaics

The 20th Century was the era of the National Park. Following the industrialisation and widespread deforestation of western countries came the realisation that habitat loss is a major cause of extinction. After the creation of Yellowstone National Park in 1872, the park model was applied across the globe, including in the colonies of the tropics. In many cases areas selected for reservation were inhabited, and so local people were displaced and lost the means to meet their livelihood needs (Peluso 1993). By the end of the 20th C the strategy had been broadly criticised, due to its insensitivity to human needs, while some also claimed that it was inherently ineffective and politically infeasible (Brandon and Wells 1994; Wells et al. 1999). For the past 30 years habitat fragmentation has largely been studied within the framework of two key theories: the theory of island biogeography (MacArthur and Wilson 1967) and the metapopulation concept (Levins 1969). Applications or recommendations for conservation have not been straightforward but the pattern of species loss from small isolates and need to consider spatial arrangement led to new concerns about the isolation of parks within a matrix hostile to wildlife. Reserves that had carried the conservation banner for the past 80 years were considered still necessary but not sufficient. There was a new wave of interest in the 'areas between' whose role in conservation had been previously neglected. This sharpened the focus on tradeoffs: between species, landuses and between conservation and people (Beehler et al. 1986; Vane-Wright et al. 1991; Quammen 1996). The pressing nature of these questions was apparent in areas of conflict between authorities and local people who had been dispossessed in the name of conservation. In response to such problematic situations, more recently conservation landscape approaches with more prominent elements of stakeholder engagement and negotiation have been developed, (see Loucks et al. 2004 for WWF, Brown et al. 2005 for IUCN).

4. New ways of doing research for integrated tropical landscape management

The concept of 'transdisciplinarity' was developed in the 1970s (Jantsch 1970; Piaget 1972) before the principle of sustainable development (Brundtland 1987) further encouraged integrative approaches. It combines disciplines and takes into account ethical values and implies the participation of various stakeholders, academic or not. Transdisciplinarity is still being studied at a theoretical level (Naveh 2001; Klein 2004; Nicolescu 2005) and has been hailed to address complex societal problems (Horlick-Jones and Sime 2004), as in developing countries. In a parallel trend, CGIAR research has evolved from a focus on agricultural productivity in the 60s to an integrated natural resource management approach (Campbell and Sayer 2003). The Integrated Natural Resource Management framework involves four sets of interrelated linkages: between 1) production and conservation, 2) spatial scales, 3) time scales and 4) research and adoption of results (Harwood and Kassam 2003). In general, the main gaps to bridge appear to be between research disciplines, different social groups (communities, scientists and policymakers) and different sets of ethical values.

Integration between disciplines, scientists and non-academic actors: The practical need to integrate landscape ecology with social, economic and political issues has inspired researchers to develop a variety of tools (Sheil et al. 2006; Tomich et al. 2006) . However, Opdam et al. (2002) argue that attempts to integrate these issues into natural resource management planning have fallen short of expectations. One of the likely reasons is a lack of variables that are comparable between disciplines and expertise in combining them (Daily and Ehrlich 1999). Transdisciplinarity places very high demands on both research and development organisations (Tress and Tress 2001) and individuals may be submerged by complexity. One strategy is to

work with teams members having strong disciplinary backgrounds and good communication skills (Daily and Ehrlich 1999), but a clear definition of the role of each actor is needed in a team (Sillitoe 2004) as well as in a network of institutions. When possible, communication should be facilitated by "bridgers" between actors (Cash et al. 2003; Tomich et al. 2006). A too close association of scientists with local actors also brings risks, such as loss of objectivity or research efficiency through too strong policy involvement (Kaimowitz pers. com.).

Integration of different perceptions: Transdisciplinary concepts include the acknowledgement of different values and Nicolescu (2005) even describes different levels or regions of reality. In practice, ICRAF has distinguished different types of ecological knowledge in its work: those of local people, politicians and scientists (Pfund et al. 2006). The Alternatives to Slash and Burn program found that enough flexibility must be given for individuals and institutions "to learn at different rates and to maintain conflicting opinions" (Tomich et al. 2006 p. 19). Such flexibility requires trust. While development agencies often support action research ideas they may simultaneously require strict planning documents that can narrow the potential for participatory problem identification and adaptive management (Wells et al. 1999). For landscape planning, CIFOR and ICRAF developed and use participatory scenario modeling (Wollenberg et al. 2000; Vanclay et al. 2003; Purnomo et al. 2004) to illustrate management options to the community. Once various perceptions and options are known, negotiation support tools may facilitate the search for compromises between groups, and when needed, the discussion of incentives (Van Noordwijk 2001; Hartanto 2003).To enable responsive adaptation of management, livelihood assets indicators (Campbell et al. 2001) are used in landscape tracking tools (Petheram 2005).

5. Conservation and development in practice

Interviews with experienced practitioners of transdisciplinary research yielded stories from the seven sites described briefly in annex 1. In the following chapter, we will focus on elements that contribute in these case studies to the strategy of integrating conservation with development.

Landscape design: All interviewed experts agreed that mosaics reflect the history of land uses and accessibility of landscapes. In undertaking conservation projects, action must be tailored to known threats as well as opportunities. To compare situations in different landscapes, there is a need for a better tropical landscape typology (Ingles et al. 2002; Tomich pers. com.), It is common that in mountainous areas such as Western Ghats, Nepal, Jambi and Central Sulawesi well-connected forests are left at higher elevations, whereas at lower elevations forests are in isolated fragments. In India ATREE has been helping local NGOs identify where to buy land to maximise critical forest connections. Jambi's formerly most intensively used areas, the riverine agroforests, are now important in providing connectivity between patches of forest and it seems that at least long-distance dispersing plants benefit from these 'stepping stones'. Studies of bird life and soil macrofauna in Jambi and invertebrates in different patch sizes in Nepal show that as intermediate land types agroforests are not perfect systems but provide important habitat for many organisms. Nevertheless, it is not well known if these intermediate habitats are sufficient for long time survival of forest interior species.

Adequate institutions: The institutional and legal context of resource use in landscape mosaics is frequently composed of customary and state rules; sometimes complementary, but frequently in conflict. These rules are often related to land rights and extraction of resources from 'public lands'. Tomich comments that these are common throughout Thailand, the Philippines, Indonesia and Pacific and that sophisticated systems penalizing misuse are part of the heritage of Islamic systems. Customary rules work effectively while everyone is using the same set. Many indigenous groups have arrangements to manage forest resources such as through sacred forests. They may protect groves and cemeteries for religious reasons (Wadley et al. 2004) or springs and rivers in dry areas such as in Tanimbar and Sumba. The commitment of people may depend on sanctions based either on spiritual beliefs or a strong community penalties to be paid

in cash or labour (such as in Tanimbar). Multiple interviewees suggested that traditional regulations should be used more frequently in modern resource regulation, such as in rural India, where Joseph said that these 'assets' should be used as communities there are not ready for nation state policies. Yet, the integration of traditional and state regulations may not be simple. One problem is the complexity and possible incompatibility of the rule systems that have been developed by disparate kingdoms. The Tanimbar project has been re-negotiating landuse designation to reduce further conflict between conservation and development interests. Here, the careful involvement of all stakeholders in the process and the lack of current conflict have enabled successful negotiations. According to Bognetteau, focusing on participatory planning, the Podocarpus program in Ecuador has helped to open dialogue between local and national governments as well as indigenous farmer groups, commercial forest users and NGOs. There co-management committees were successful in negotiating national reserve status for a lowland forest area threatened by gold mining and logging.

Local empowerment: According to Tomich, poor rural communities are typically insufficiently empowered to negotiate with incoming stakeholders such as resource extraction companies. He sees a need for public advocacy to provide communities with basic information about their options and how arrangements with outside players will work. Similarly, Joseph states that in the Western Ghats communities need assistance in negotiation, and that the resource companies are also using NGO consultants for negotiations, as they are not confident of breaching the social divide**.** In contrast, Joshi considers that in northern Nepal local people are probably empowered to negotiate, as land tenure is clear. In the context of Lore Lindu, Palmer believes that the NGOs have tended to be paternalistic and assume that local people needed help. It is not clear if this is leading to empowerment when there is neither sufficient financial backing for projects nor encouragement of local initiatives. More positively, in Sumba, BirdLife had an intermediary role in negotiating National Park boundaries and resource use by the community with government agencies, while in Tanimbar, locals were incidentally helped to overcome their shyness in communicating their needs to government agencies. Thus, while the effectiveness of the negotiated arrangements varies, in many of the cases explored, NGOs do seem to have a role as a negotiator or intermediary.

Awareness building on biodiversity and environmental services: One other realm of empowerment that emerged in these stories was that of education. In Sumba, BirdLife focused on endemic birds and attempted to raise local pride and responsibility regarding these species. According to Wood, the traditionally strong respect for law in that society has assisted messages about the illegality of hunting the endemic Sulphur-crested Cockatoo subspecies (*Cacatua sulphurea citrinocristata*). BirdLife has also linked the conservation of cockatoos to issues of forest ecology and preservation of water sources to give it more immediate appeal to the community (Salafsky and Wollenberg 2000). Laumonier explains the unusal success of the awareness program in Tanimbar was by many months spent by the socialisation team, going between villages to make sure that people understood what the project was about and what its relation to locals was. It enhanced the communication between all the relevant stakeholders giving for the first time an opportunity for local people to have their voice heard. Awareness raising activities may also be directed at managers and decision-makers; ASB's research showing that intermediate land uses may be rich as habitats has had an influence on official perceptions, adding recognition of the value of traditionally managed systems and giving more options for improving biodiversity value at the landscape level.

Sufficient capacity by NGOs: The need for assistance in resource negotiations and dissemination of knowledge turns the focus to conservation and development NGOs. While aiming to raise capacity of local communities, in some cases they also have insufficient resources for the tasks at hand. Palmer is sceptical of the role that NGOs are playing around Lore Lindu. There are over 30 organisations working in the area with poor inter-coordination.

He also believes that some of these groups are not equipped with the skill sets required to integrate societal objectives into conservation schemes. While there has been widespread facilitation of agreements between the community and National Park, sometimes many local people remain unaware of these. Perhaps this shows symptoms of the growing requirement for NGOs to be 'all things to all people', filling both biophysical and social roles, when this is in fact beyond their scope. It seems that in a transdisciplinary context, the answer to this dilemma may lie in effective partnerships and investments in capacity building.

Local versus outside motivation to conserve biodiversity: Sheil et al. (2006) argue that the preferences and perceptions of local stakeholders often remain hidden when conventional biodiversity surveys are conducted and that misunderstandings may lead to irrelevant or short-term decisions. Surveys from Lore Lindu suggest that biodiversity per se is not very relevant to local people, especially for those who are poor. A utilitarian view of biodiversity seems to be common among all case studies. Local people may have detailed knowledge of fodder systems including animal preferences and seasonality as well as tree-crop interactions, as clearly established in the Nepal case, or thorough understanding of the species they harvest, as in Sumba. According to Laumonier in Tanimbar, overharvesting may still be a problem and species such as dugong are locally extinct. Nonetheless Tanimbar is special in that the community has thus far denied the access of logging companies to its forests and so most of the forest cover remains. In some cases, an unsustainable use of resources can be explained by a lack of internal cohesion, caused for example in Lore Lindu by recent resettlements, meaning that transmigrants lack a strong attachment to the land and local rules. However, co-management efforts can also lead to negotiated solutions as in the Podocarpus program where colonists are granted legal rights to land if maintained under forest and they allow hunting by indigenous groups.

Rewards for biodiversity conservation: Palmer argues that if conservation in developing countries is not properly resourced with sufficient compensation for locals, it will fail. He believes that the national park system may be not applicable in Indonesia and different approaches to conservation are needed. One form of incentive has emerged through new markets for cultural ecotourism, although these have often not met expectations. In Ecuador, the translation of local park management plans into more clear and secure land access rights, access to safe drinking water, sustained yields of previously threatened tree products, more sustainable land use practices and ecotourism revenues make local people more aware of the benefits of conservation. In all case studies, the difficulty in rewarding locals directly for biodiversity conservation was evident. In Lore Lindu, STORMA (Stability of Rainforest Margins in Asia) is exploring direct payment schemes as well as incentives for growing cocoa under shade, thus increasing its habitat value. However, in Zona da Mata, "green coffee" marketing has been problematic due to a lack of market linkages. Joseph is exploring research results in the Western Ghats, with the view to convince policy makers to use State taxation to pay for goods and services to compensate land managers for their environmental services. Meanwhile, Tomich mentioned that measurable indicators for biodiversity service provision still need to be negotiated, but transaction costs are frequently very high.

6. Partnerships to promote biodiversity conservation and enhanced management of tropical landscape mosaics

In 2006 CIFOR and ICRAF launched a 'Biodiversity Platform' during a workshop of over 30 scientists from various disciplines (ecological and social sciences, livelihoods and governance). The Platform aims to identify principles and practices that promote conservation, sustainable use and equitable sharing of biodiversity goods and services in landscape mosaics. Within the studied landscapes, it will focus on 'intermediate landuses': remnant, managed and secondary forests, agroforests and plantations. Participants debated the scientific (research gaps) and

development (impact pathways) aspects of conservation and production in mosaic landscapes. Participatory action research was accepted as the general approach but the risk of reduced scientific quality was also highlighted. Thus we have developed a combined approach.

To allow cross landscape comparisons and deliver internationally applicable results, the following four main hypotheses were created: 1) External conservation values and local values of biodiversity goods and services vary non-linearly in time depending on the landscape mosaic and overall intensity of use. Possible shapes of this curve are suggested for various landscape types; 2) timely empowerment of local populations through integration of scientific and local knowledge will mitigate biodiversity loss and maintain or increase livelihood security; 3) reward mechanisms will only work where local regulations based on local environmental services can constrain individual decisions, if external commitment is serious and follows up on promises made; 4) overall landscape sustainability is enhanced if public policies are informed by and allow for customary or local rules and practices.

These hypotheses will provide a common framework for participating scientists from different disciplines and sites. For each hypothesis, a 'thematic' group of researchers will facilitate information and experience gathering (Lélé and Norgaard 2005). For impacts to be felt in the field, we will need flexibility to ensure participation and suitability to local contexts but a common data set will also be required. Spatial analyses and a set of common aggregated data (see matrices and methods developed by other site networks in Ostrom 1995, Tomich et al. 1998, Colfer 2005) will be standardized across the Platform's landscapes. Finally, to take into account different perspectives of stakeholders in biodiversity, three foci will characterize field surveys: biodiversity products useful for the *local population* (non timber forest products, game), species having special existence values for *conservationists* and finally biodiversity indicators for *scientists* as they will also allow cross-site comparison. The species-sorting perspective (Leibold et al. 2004) will be used to study linkages between patch structure and species. Scientific credibility and the development of an updated set of useful tools and technological knowledge to benefit local partners in each landscape will be emphasized.

Thus, the proposed steps to be taken by the Platform for its transdisciplinary research are:

- Collection of information about members' research and development priorities and collection of tools (biodiversity assessment, landscape description, participatory problem definition, landscape assessment and negotiation or decision support tools)
- Selecting of landscapes having a clear dual conservation and development value
- Creation of institutional partnerships
- Landscape definition and spatial analysis of landuse change and its drivers
- Collection of data of local relevance as well as standardized biodiversity indicators
- Scenario development, possible use of models simulating stakeholders' decisions
- Support to negotiations through partnerships and promotion of long term collaborations
- Regular monitoring and evaluation of progress and outcomes for adaptive management

7. Conclusion: research for development in landscape mosaics

It is clear from past experiences of field researchers and practitioners that development and conservation issues in landscape mosaics need to be approached in a nuanced and socially aware way, considering the interests of many stakeholders. Inter- or transdisciplinarity have been increasingly proposed for effective work in complex landscapes. This was the starting point for CIFOR and ICRAF in launching a joint initiative to support management and biodiversity conservation in tropical landscape mosaics.

Empirical evidence demonstrates that forest fragments and intermediate-intensity land uses provide important biodiversity conservation services that complement those of dedicated

reserves. However the segregation of conservation and livelihood issues in the majority of the available literature as well as field experiences of interviewees show that much remains to be learned regarding their successful combination. Thus, a combined approach of hypothesis-driven and participatory action research is proposed to both provide international public goods and support negotiations for improved and adaptive landscape management. The framework of the Platform's transdisciplinary research on biodiversity in landscape mosaics include a few meaningful cross-site hypotheses and data collection frames, the development of management scenarios considering various stakeholders' ethical values and priorities and the provision of tools for supporting negotiations at multiple spatial and political levels.

In tropical landscapes, linkages between disciplines and a research-development continuum must be ensured to effectively combat poverty and environmental degradation. In order to maintain credibility, salience and legitimacy (Cash et al. 2003), scientists can combine the search for local impacts with cross-site analyses to extrapolate results. However, in the field, scientists face challenges in integrating disciplines and involving multiple actors with differing values. Typically, they cannot do this alone; success requires clear and strong partnerships and their facilitation. For long-term success of such complex research approaches, scientists must go beyond academic norms. Yet incentives for transdisciplinarity are rare in the current system, which emphasizes scientific papers. In the field, the goodwill and openness of many actors is needed for tangible improvements and acceptable compromises between conservation, private sector, government and local interests. Nonetheless, the effective combination of biodiversity information that interests the key players may help to facilitate communication and achieve good landscape level outcomes for both biodiversity conservation and livelihoods in the tropics.

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Annex 1:

The very biodiverse Lore Lindu national park in mountainous central Sulawesi in Indonesia is the location of a new study of the impacts of conservation and land use right agreements that conservation organisations have facilitated between the National Park management and the surrounding communities. Interview with Charles Palmer of ETHZ, Switzerland.

In Zona da Mata in the Atlantic rainforests of Brazil, the forest has been reduced to 7%. This increases the importance of a scheme initiated by a church-based group, which has bought land for the landless, but with management conditions requiring it to be done in an environmentally sensitive manner. Interview with Irene Maria Cardoso of Federal University of Viscosa, Brazil.

The Western Ghats forms a spine down the west side of India. It has a patchy landscape of agriculture,rainforests, grasslands and, plantation forests. The Ashoka Trust for Research in Ecology and the Environment (ATREE) is focusing on Biligiri Rangaswarmy Temple (BRT) wildlife sanctuary area, aiming to help local people to benefit more from their forests and enhance forest conservation. Interview with Gladwin Joseph of ATREE, India.

BirdLife Indonesia has a project to promote participatory management of National Park forests in Sumba island, Indonesia. This small hilly island consists largely of grasslands and agricultural areas with most of its remaining forest in two national parks. Most of the rural people living around the national parks have gardens or farm land inside the old park area. BirdLife has facilitated agreements between the state and local people about the new park delineation. Interview with Pete Wood and Syarif Indra of BirdLife Indonesia.

The system-wide Alternatives to Slash and Burn (ASB) program in the Consultative Group on International Agricultural Research (CGIAR) called has several benchmark sites, including one in Jambi Province in Sumatra. Here, researchers have worked with the community to identify options for a better balance between conservation and development. Jambi is a major rubber producer, with farms varying from monocultures to riverine junglerubber agroforests. ASB is interested in incentives for the more biodiverse agroforestry systems to be retained while forests are being rapidly converted into plantations. Interview with Tom Tomich of ASB, Kenya.

The Pakhribas Agricultural Centre in the East Mid-Hills of Nepal ran for 25 years as an independent research centre with secure program-based international funding. This stable situation allowed them to have a strong program of agricultural research and capacity building of both local farmers and the national agricultural institute. Interview with Laxman Joshi, formerly of Pakhribas Agricultural Centre, now ICRAF, South-East Asia.

Dry tropical forests cover 70 % of the land area of Tanimbar island, Indonesia. People concentrated on the coasts mainly rely on subsistence agriculture and fishing. Traditional rules are strongly followed and biodiversity of forests is generally well protected. CIRAD (Centre de coopération internationale en recherche agronomique pour le développement) has undertaken field research and negotiation to create a more workable designation of land uses partly as a response to earlier efforts by companies to log sensitive areas. The project brought together data on flora, fauna as well as social elements. Interview with Yves Laumonier of CIRAD, Indonesia.

Podocarpus National Park, located in Southern Ecuador is an area of mega-diversity including a range of lowland Amazon to Andean cloud Podocarpus forest ecosystems along an altitudinal gradient. The Podocarpus Program facilitated the multi-stakeholder management of the Park and its larger region, emphasizing participatory planning, benefit-sharing and social acceptance. Interview with Els Bognetteau, formerly with the Dutch Cooperation in Programa Podocarpus, now with Sustainable Livelihood Action, The Netherlands.