

Figure 2.8 Diversity of habitats across the study region using different scales.

For both habitat diversity and species diversity, the maps show high diversity values in western Amazon and in the Andes. Montane forest and montane grasslands had high values in terms of habitat diversity. *Várzea* and moist forests showed the highest richness values for species richness.

Table 2.16 Distribution of habitat and species diversity among major ecosystems

Ecosystem	Habitat Diversity (indexed)			Species Richness (no. species)		
	Protected area	Indigenous territory	Non-protected/non-indigenous	Protected area	Indigenous territory	Non-protected/non-indigenous
Dry forest	0.661	0.631	0.760	576.353	564.067	504.420
Guayanan	0.679	0.591	0.697	626.416	656.401	653.683
Mangroves	0.517	0.628	0.633	708.088	494.092	508.229
Moist forest	0.391	0.411	0.371	676.551	654.989	677.263
Montane forest	0.944	0.771	1.188	567.283	601.871	392.154
Montane	1.293	1.529	1.119	333.557	323.031	222.463
Savanna	1.055	0.896	0.813	576.427	613.293	516.085
Swamp forest	0.521	0.756	0.398	748.436	544.254	662.013
Várzea	0.431	0.637	0.573	664.980	718.748	719.396

2.7.1.2. Implications for poor local stakeholders

Habitat quality itself, although related to forest product provision (next section) and other direct use services, has little direct use value for local stakeholders. It is, thus, a rather globally valued ES. A considerably high willingness to pay exists among external beneficiaries for biodiversity existence and option values in undisturbed ecosystems, preferably with exotic fauna. Although few concrete examples exist in the Amazon, such values can potentially be internalized locally through PES and PES-like schemes that involve direct payments for biodiversity conservation. The minimum conditions for this mechanism to work (additionality and property rights) apply here as well (see also section 2.5.2 and Chapters 3 and 4). Tourism and ecotourism (Chapter 4) are frequently cited examples of mechanisms through which local stakeholders can also benefit through direct (recreational, cultural) use values of biodiversity. However, especially in the Amazon, few experiences exist.

Table 2.17 Stakeholders and habitat quality

Local stakeholder groups	Well-being implications of key results
Urban	Few potential benefits arise as a result of indirect values of biodiversity. Threats to habitat quality and related direct use values might compromise income of urban stakeholders involved in tourism business. Since more tourism options exist in the Andes this is currently less relevant in the Amazon.
Colonists/farmers	Farmers with property rights in areas with still high but threatened habitat quality (see right panel in Figure 2.7) could benefit if demand for biodiversity conservation materializes.
Traditional/Indigenous	Many indigenous territories are located in remote/less disturbed areas with a potentially high biodiversity value. Whether PES schemes or ecotourism are feasible benefit transfer mechanisms needed to be evaluated in each case.

2.7.1.3. Provision of forest products

Selected for the analysis of forests products were: timber, fruits and nuts (and other foods from plants), fibre, medicinal plants, and bushmeat. A literature review identified species in these groups of importance to the livelihoods of different users in the Amazon basin and beyond. For these species, patterns of current distribution were estimated by comparing points of occurrence available in online collection databases with the TNC map of ecological systems for South America (Sayre et al. 2005). Species were also grouped according to beneficiaries: 1) medicinal species used by local communities (subsistence), 2) commercialized medicinal species, 3) timber species for local use, 4) commercialized timber species, 5) fruits and nuts for local use, 6) commercialized fruits and nuts, 7) fibres for local use, 8) commercialized fibres, and 9) locally consumed game. There was considerable variation in information available on species for each group.

Provision of ES was mapped for each of the eight groups of species defined above. The model considered that the current existence of the species in each group (and the provision of services associated with them) is a function of past patterns of use. The model combines the index of habitat quality and values of accessibility to estimate areas where the species in each group are no longer present, or conversely, where they should still be encountered. The maps provide a regional perspective in terms of areas of importance related to the concentration of species that provide specific services for different groups of users. A map is presented below with the example of the results for fruits and nuts (food) for local consumption (Figure 2.9).

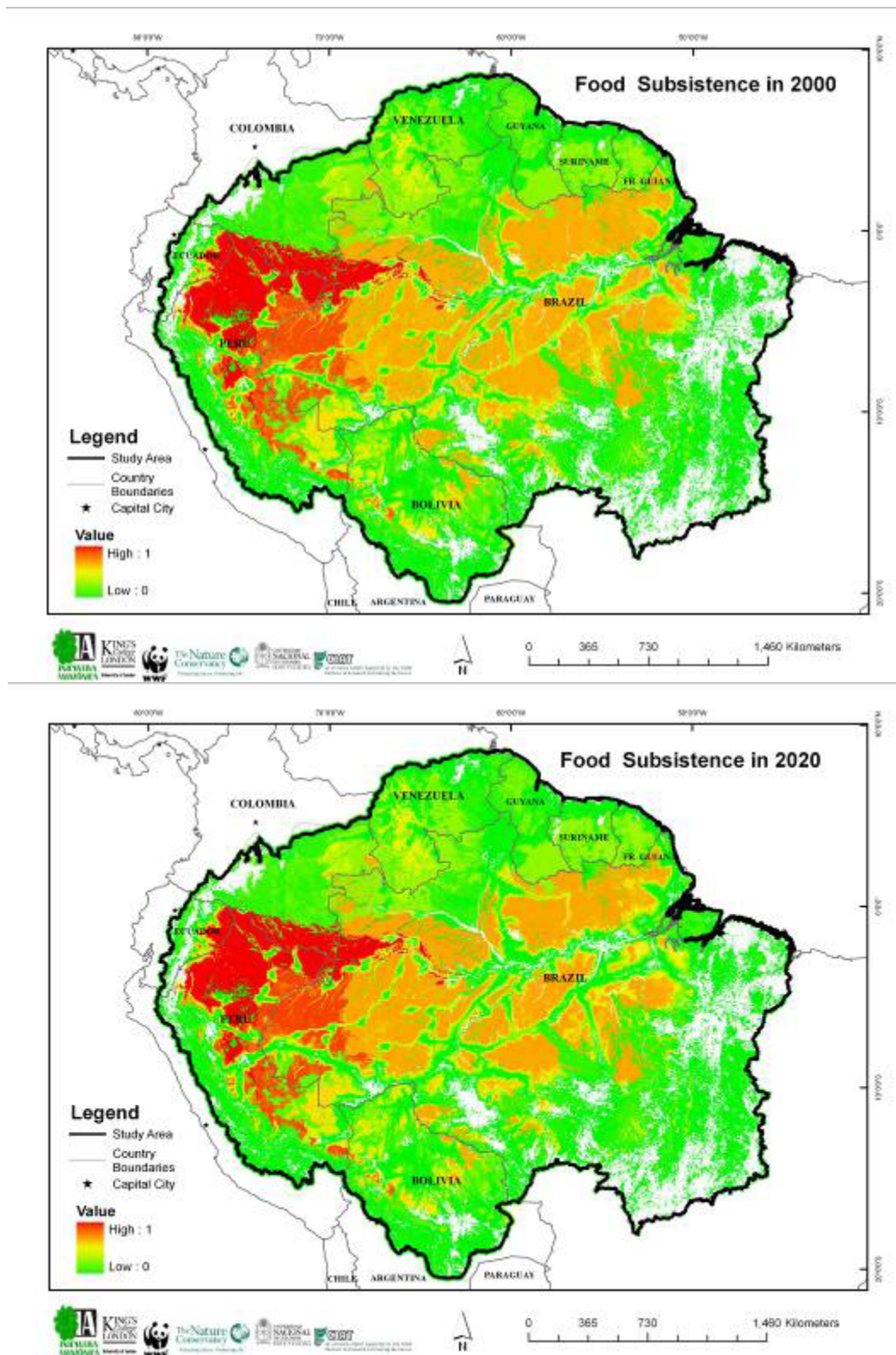


Figure 2.9 Provision of biodiversity for food in 2000 (top) and under future scenario for 2020 (bottom)

The results regarding timber and non-timber forest products showed that moist forests and *várzea* forests were the ecosystems with the highest provision of forest products. It is important to mention that moist forests occupy a much larger extent of the study area than other ecosystems, so it is expected that will have a higher importance in provision of forest products. Indigenous territories and protected areas have higher importance than background and urban areas in terms of provision of forest products. In particular, indigenous areas show the highest potential for forest products provision. The forest products provision maps also showed a higher value of provision in Western Amazon. Under the 2020 scenario, moist forests and montane forests have the greatest loss in terms of provision of forest products. The model also shows unsurprisingly that non-protected/non-indigenous areas will suffer the greater loss of ES provision.

It becomes evident from the results that patterns of habitat quality, provision of ES, species richness and habitat diversity do not necessarily coincide in space. In certain cases, areas of high biological diversity in terms of species richness (e.g. moist forests) also present high levels of provision of ES related to timber and NTFPs. However, these areas do not present high diversity at the ecosystem level. This condition could be different for other types of ecosystem services such as pollination, water provision, and hydrological regulation. It is likely that the structure and composition of the landscape becomes a critical factor for the sustenance of these services. In general, it was evident that protected areas and indigenous territories play an important role in the provision of biodiversity and forest products.

The result maps and tables were useful to show general patterns of habitat quality and forest products provision in the study area, but they should not be used to interpret local distribution patterns. Detailed maps and methodologies are available in the Annex section.

2.7.1.4. *Implications for poor local stakeholders*

Few urban, peri-urban and agriculture-based livelihood strategies involve high degrees of dependence on forest products. Exceptions may be some products with developed markets, such as timber, and special fruit products (e.g. Açai or *Euterpe oleracea*). Some traditional populations, e.g. rubber tapers, have specialized in particular forest products, while indigenous populations are generally dependent on various forest products. The results in this section indicate where natural provision of forest products is high and where forest products are under pressure from deforestation and forest degradation. Where this pressure coincides spatially with land occupied by traditional and indigenous populations negative welfare effects for these groups are likely especially if they are not involved in (and capture the benefits of) the economic activities that reduce natural forest cover.

Table 2.18 Stakeholders and forest products

Local stakeholder groups	Dependence on forest products	Well-being implications of key results
Urban	Generally low, but eventually high for specific products and their value chains	If specific products are affected by deforestation and degradation, negative well-being effects are likely
Colonists/farmers	Moderate, depending on distance to market and forest product availability	Most farmers and colonists derive benefits from forest conversion. Hence, loss of forest products is compensated for. Exceptions exist where external pressure on forests compromises forest product provision for agriculture and extractivism based livelihood strategies.
Traditional/Indigenous	Often high and diversified	Locally, open access situations of forest product extraction might contribute to negative welfare effects where traditional/indigenous populations are both ES users and modifiers. But generally, it is external pressure, e.g. on unprotected indigenous lands that compromise extractivism based livelihood strategies.

Key research issues and questions to be addressed by ESPA: Ecosystem functioning

1. Better understanding of the scale (potential thresholds) and land cover characteristics required to maintain ecosystem services related to biodiversity (e.g., there is no information available regarding the scale for maintaining supporting services such as nutrient cycling or ecosystem stability).
2. Establishing the links between biodiversity at different levels (i.e. species, ecosystems) and the provision of specific ecosystem services (ES) such as nutrient cycling, ecosystem stability and disease control.
3. How human disturbances and habitat degradation can affect the provision of different ecosystems services provided by natural ecosystems. What are the thresholds, resilience and resistance of natural ecosystems to change before they start losing the capacity to provide different ES.
4. Better knowledge about biodiversity products (e.g., sustainable extraction rates, phenology, etc.) provided by the Amazon is needed to improve management and sustainable use; information is not well systematized for the region; some countries have only very basic information (e.g., Guyana).
5. Information on distribution of timber and non-timber forest products species and their use needs to be improved. Without precise information on species distributions, it is hard to estimate real provision or provision of forest products in the region.
6. Better understanding of the relationships of species valuable for humans, their ecosystems, the economics of extraction, and related value chains is needed to ensure sustainability of product extraction.
7. A lot of the existing information is unorganized and hard to find. A coordinated effort among countries in the region to create and manage a long-term biodiversity (existence and use) information system that can maintain updated information on biodiversity and forest products that benefit human livelihoods is needed.

Further information: Baseline datasets in Google Earth (www.ambiotek.com/ESPA) and details on the terrestrial biodiversity analysis are available in Annex 6.

2.7.2. Aquatic biodiversity

Aquatic biodiversity is of major importance in the Andes/Amazon region. It sustains some sectors of the population, provides basic nutrition for rural and urban inhabitants, and is a dynamic economic, social, and cultural element (Alonso et al. 2008). This section examines the current situation of aquatic biodiversity, with a focus on fish resources and fresh water ecosystems.

2.7.2.1. Fish resources

The Amazon watershed harbours some 2,500 fish species (Gery 1984; Barthem, & Goulding 1997; Alonso et al. 2008). This biodiversity is not uniformly distributed across the region: Brazil has the greatest number of species (nearly 2,000), followed by Colombia (1,177), Peru (814), Venezuela (939), and Bolivia (635).

A large part of the Amazon economy is based on the use of this diversity of aquatic organisms, especially fish (Alonso et al. 2008). Commercial fishing for consumption uses approximately 200 species (Gery 1984). Capture of ornamental fish spans nearly 350 species (WWF, Incoder and Traffic 2006).

For this analysis, the study region was subdivided into 19 freshwater ecoregions (WWF and TNC 2008); and richness was mapped for each of these (see Annex 7 for figures). The greatest richness is found in Amazon Lowlands (880 species), Rio Negro (616 species) and Orinoco Guyana Shield (610 species). The greatest endemism is found in Amazon Lowlands (880 species), Guyana Shield (145 species) and Tocantins–Araguaia (115 species).

We identified locations with abundant fish resources where sustainable fishing could contribute to maintaining local communities' well-being and quality of life. We reviewed the literature and compiled fisheries' statistics from countries in the region. Results are used to estimate the approximate fisheries provision and need.

An estimated 365,550 tons/year of fish are consumed; and 220,200 tons/year are commercially traded. The estimated total (566,750 tons/year) is roughly half of the potential provision (Merona 1993). Seasonal variations in fish provision are related to the seasonal variation of water level. During the seasonal floods, resources are dispersed throughout the basin and, consequently, fishing is less efficient and productive. Fish provision falls below need—especially urban—during this period, leading to price increases. During the dry months, productivity and efficiency are higher due to concentration of fish resources. Montreuil et al. (1991) report that in Peru at least 70% of the capture is recorded during this period when provision greatly exceeds need and prices fall.

Over the years, provision of some species has declined and has been replaced by others. Taking the longest statistical series in the Ucayali region of Peru, the take of *dorado* (*Brachyplatystoma rousseauxii*) dropped from around 320 tons in 1980 to 22 tons in 2006. Species such as the *palometa* (*Mylossoma duriventris*) and sardine (*Triportheus spp*) that had very small catches in 1980 are now, along with the *bocachico* (*Prochilodus nigricans*), the most important commercial fish species in the Ucayali region. Capture rates throughout the Amazon have changed due to excessive fishing of some species (Alonso et al. 2008).

Main fish provision areas are shown in Figure 2.10. The greatest resources occur in the lower

watershed of the Amazon in the states of Pará and Amazonas, which correspond to approximately 28% of the total provision of the region.

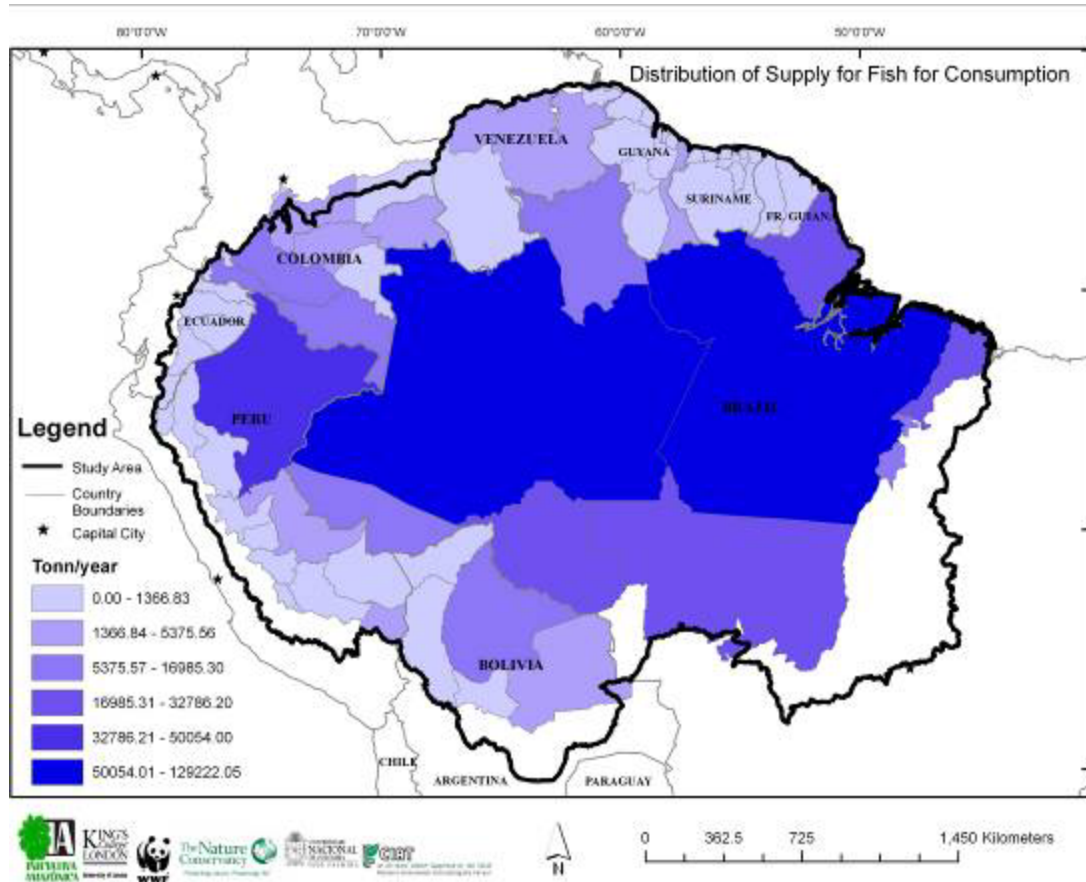


Figure 2.10 Distribution of provision for fish for consumption

i. Surplus/Deficit from fisheries

Deficit or surplus of fisheries' resources was calculated to show the areas apt to provision the need within and beyond the Amazon (blue in Figure 2.11) and areas with fish deficits (shades of green). Areas in light blue have minimal deficits, possibly due to lack of systematization of information or areas supplied by resources from local aquaculture.

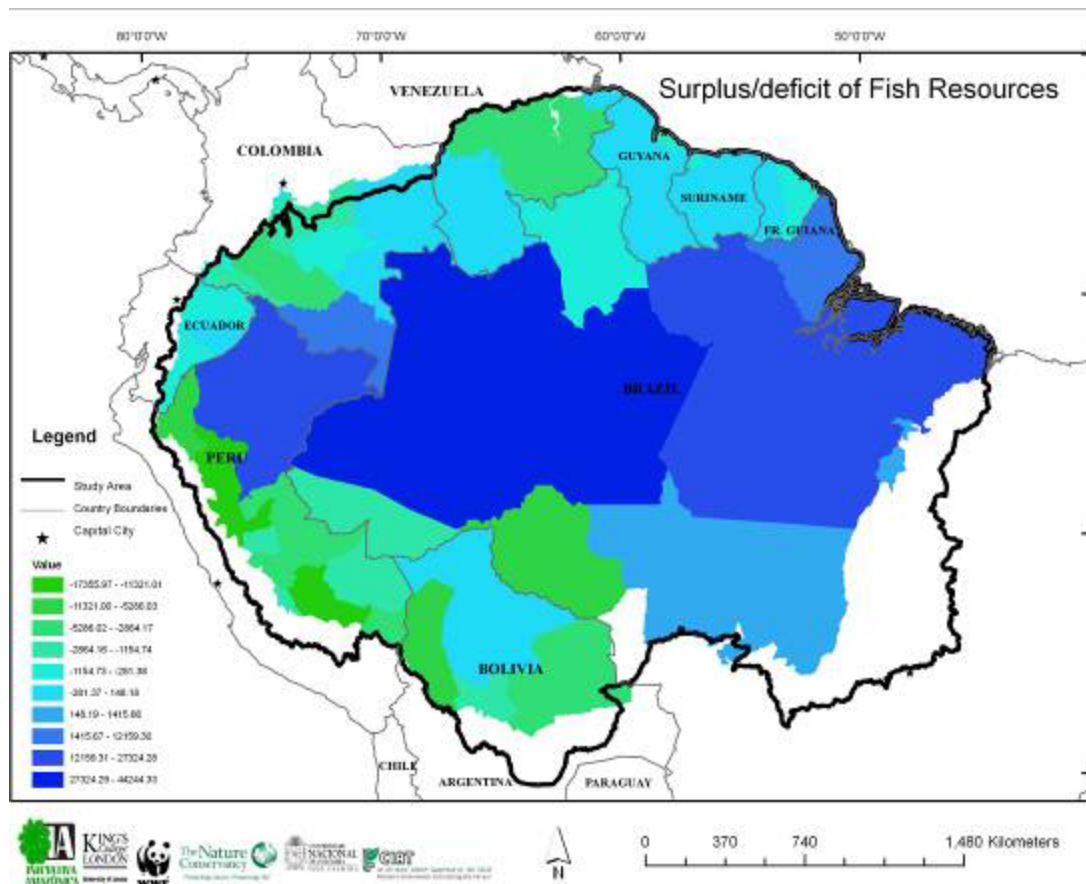


Figure 2.11 Surplus/deficit of fish resources in the Andes/Amazon

2.7.2.2. Implications for poor stakeholders

Based on regional data, fish resources can only be assessed at very broad regional scales. The urban poor are seldom directly involved in fishery, but might be affected through the value chain. Both colonists/farmers and the traditional/indigenous population are known to engage in fishery to complement diets and diversify income sources when they have access to fishing grounds. Income can be negatively affected especially where high value fish species, e.g. pirarucu (*Arapaima gigas*), are in decline. Local deficits (Figure 2.11), i.e. fish consumption greater than local supply, do not necessarily imply negative well-being effects. In fact, such deficits indicate that fish is imported from other regions, which implies moderate to high welfare levels. The contribution of fish to local well-being (and potential threats) are clearly knowledge gaps that deserve further analysis in terms of ES – poverty relationships.

2.7.2.3. Freshwater ecosystem assessment

Complementary to the exercise conducted for terrestrial ecosystems, the freshwater ecosystems analysis considers habitat quality, threats to aquatic systems, potential degradation, hydrological characteristics, and the capacity of the ecosystem to respond to disturbance. Analysis evaluates threats that affect aquatic ecosystems: i.e., agricultural ecosystems conversion, deforestation,

infrastructure (dams), human based contamination, and exploitation of oil and gas. Potential degradation and the ecosystem response are estimated for each threat (as per Polasky et al. 2007).

Figure 2.12 shows that basins with greater ecosystem degradation are located in the piedmont of Colombia, Ecuador, Peru, and Bolivia, and the southern Amazon Basin in Brazil (e.g., the Mamoré River Basin).

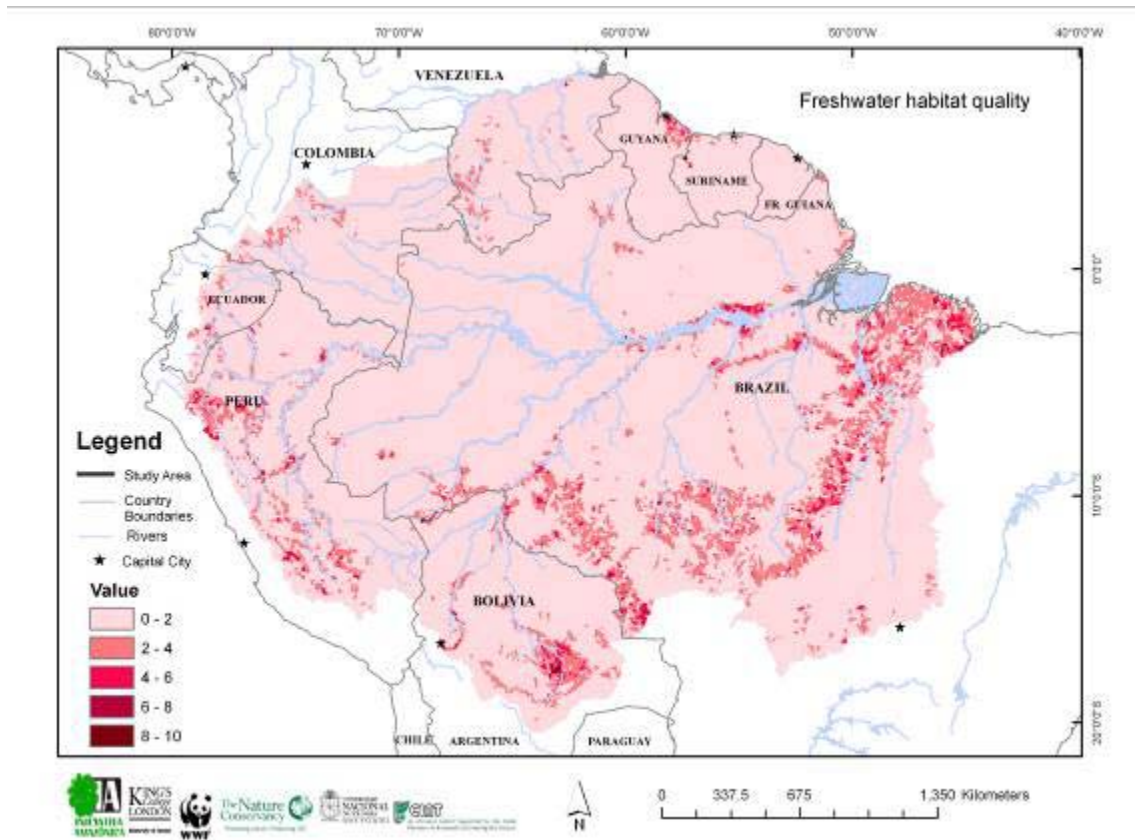


Figure 2.12 Freshwater habitat quality

Deforestation and oil drilling are the threats in the Putumayo, Caqueta, and Guaviare River Basins in Colombia, and in the Pastaza River Basin of Ecuador. Natural systems have been affected near Iquitos, Peru, by deforestation and urban pollution. Also affected are the piedmont areas of the Ucayali and Huallaga Rivers and their main tributaries near Tarapoto, Yurimaguas, Huanuco and Pucallpa. The Beni and Mamoré Rivers in Bolivia are affected, respectively, by the city of La Paz and by deforestation and agribusiness in Montero and Santa Cruz. The Madeira Basin and its tributaries Ji-Paraná, Jamari, and Rio Branco in Brazil are heavily affected, especially by dams coupled with deforestation and pollution from nearby cities. The Tapajós, Xingu, and middle - lower Tocantins basins are characterized by high levels of agricultural conversion and degradation.

The main channel of the Amazon River and lowland areas around Manaus, Santarém, and Parantins in Brazil; and Iquitos in Peru are highly affected by these urban centres. The Guyana aquatic ecosystems that drain into the Atlantic have been degraded by deforestation and agribusiness along the Georgetown – Linden corridor. See Annex 8 for detailed analysis and maps of freshwater ecosystems.

2.7.2.4. Implications for poor stakeholders

Since potential pollution is used here as an indicator for habitat quality, the results reinforce the implications for poor stakeholders from sections (2.3.1, 2.7.1.2, and 2.7.2.1). Freshwater habitat quality, as long as it does not compromise local livelihoods through reduced drinking water quality or fish stocks, is primarily a globally valued ES. However, health problems related to water pollution have been reported by both indigenous populations and colonist/farmers. They can also be a problem among urban dwellers with no access to basic sanitation services.

Further information: Baseline datasets in Google Earth (www.ambiotek.com/ESPA)

Key research areas to be addressed by ESPA: Aquatic biodiversity

1. Fish stock and population dynamics are not well understood. Provision studies in the Amazon have been limited in scope, isolated, and are of limited use for comparative studies. In the lower Ucayali in the Peruvian Amazon, Montreuil et al. (2003) evaluated species composition and provision by monitoring dock unloadings. Riofrio (1998) estimated provision by relating capture amounts vs. fishing effort in Pucallpa; as did Tello and Bayley (2001) for the commercial fleet at Iquitos. Guerra et al. (1990) and Granados (1987) estimated fish biomass (ichthyo-mass) by acoustic means.
2. Sustainable catch rates and required close seasons need to be established for threatened fish species.
3. The economics of fish supply and consumption have to be better understood in order to develop effective resource management strategies.
4. Fishery based value chains are not well studied and supposedly very heterogeneous across the region. It is not clear where degraded fish resources will compromise the well-being of the poor.
5. Fish resources are not only threatened by over fishing. ES that support fish resource maintenance need to be better understood to evaluate impacts of deforestation, hydroelectric dam construction and other measures.

3. Critical analysis of options to manage ES in the Andes/Amazon Region

3.1. Introduction

This chapter reviews the diverse set of options to manage ecosystem services with a particular, but not exclusive, focus on the Andes/Amazon. By focusing on the question: What do decision-makers need to know to make better decisions with regard to ecosystem services management? Our principal aim is to extract research and capacity-building priorities for better informed decision-making.

Decision-makers have three choices regarding the management of ecosystem services (ES): a) which ES to manage, b) the quantitative and qualitative objectives associated with each ES, and c) the “management options” (MO) for achieving these specific objectives. This chapter focuses on the final choice, that of selecting the proper MO from an array of options that includes the “standard” set of MO that are generally implemented by policymakers (e.g., land use regulations, taxes, subsidies, user fees), as well as a broader set of MO that require collaboration with stakeholder groups (e.g., reallocation of property rights and joint management of common property resources). Choosing among alternative MO can be difficult due to lack of information regarding relative effectiveness of the MO or to trade-offs between MO poverty outcomes and ES flows. Moreover, MO can reflect particular policy decisions (e.g., that define water rights in MO based on water markets). As such, policy-makers both influence potential MO and are faced with changing contexts over time in which MO are employed.

The rationale for public policy attention paid to ES is clear. ES are largely public goods in which environmental externalities, missing markets, and information asymmetries are characteristic. This holds especially for the ES described in sections 2.3, 2.4 and 2.5, but also some of the ES grouped under the category ecosystem functioning (e.g. existence values of biodiversity). In most cases, public good type of ES will be undervalued and overexploited without public sector interventions (Belli et al. 2001). Even ES that provide private benefits can be under- or overused due to “conservation investment poverty” (Vosti and Reardon 1997), i.e. lack of means to invest into the maintenance of natural assets. These cases also merit public policy attention. Because implementing MO is never costless, the existence of, for example, a market failure in the context of a given ES is not sufficient to justify policy action. Decision-makers must first assess the value to society of the effects of such a market failure, and also assess the effectiveness and costs of alternative options. In the case of water pollution, (see section 2.7.2.2), stakeholders may decide to invest in water treatment plants that substitute for natural water-purifying ecosystem services, especially if the demand for water purification can only be met by a large expansion of natural purification systems, and this expansion displaces income- and employment-generating activities in upstream areas.

Taking any action at all requires at least one MO for which the sum of expected benefits to society outweighs the sum of expected costs of implementing it over a specific time period^{3,4}. If this is not the case, then the socially optimal response is to take no action until this basic relationship is

³ These sums of benefits and costs represent the discounted streams of annual benefits and costs attributable to the MO over a specific decision-making time period.

⁴ The word ‘expected’ is inserted here to introduce the notion of uncertainty in the flows and values of ES, and also the uncertainty in the performance of alternative MO. We will take up this issue of uncertainty later in the chapter.

altered.⁵ When several MO exist that pass this first fundamental test, attention is then focused on the relative performance (see below) of alternative MO.

If specific objectives are identified related to a specific ES, the challenge is to identify a MO to get the job done. Ideally, one MO would be clearly superior in every way to all other alternatives (e.g., is effective, inexpensive, can be paid for by ES users rather than taxpayers, reduces poverty, and does not degrade other ES flows). Such MO are rare to non-existent, in large part due to trade-offs among development objectives and ES (Lee & Barrett 2001). MO differ by strategy and objectives: some may be quick and cheap to establish but ineffective at achieving stated policy objectives. Some MO may negatively affect the poor; while others may reduce poverty. Each MO will have characteristics that need to be identified and measured before selection can be made. Not surprisingly, chief among these characteristics is a measure of cost-effectiveness⁶ (Moran et al. 1996).

Regarding trade-offs, Table 3.1 sets out candidate MO for retaining above-ground carbon in the Amazon: paying farmers to retain forest cover, forest use regulations, and establishing a cap-and-trade system that any land owner could participate in. If policymakers want to increase amounts of carbon retained on private forested land, they must decide on how to achieve this objective. To choose among MO, policymakers need the information in each cell of Table 3.1. It is unlikely that a given MO will dominate all others in all of the columns. For example, forest use regulations may be effective at achieving carbon-retention objectives and inexpensive to set up (though perhaps less to operate), but this particular MO may have adverse effects on rural poverty (Vosti et al. 2002). At the other extreme, a cap-and-trade system may be the most economically efficient and provide the greatest benefits to the rural poor; but this MO may be very expensive to establish and operate--especially in the hinterlands where markets function poorly and the rule of law is often lacking. Trade-offs among evaluation criteria for selecting MOs are likely to exist.

The size and direction of these trade-offs will depend on the socioeconomic, ecological, and institutional context in which ES flows occur and in which the MO will be undertaken. These factors vary over time and space with perhaps predictable effects on ES flows and MO characteristics. For example, a specific MO that was highly effective in managing an ES in densely populated micro-watersheds in the Andes region may be ineffective in managing the same ES in the Amazon because of low population density and poor transportation infrastructure. Considering change over time at a given locale, climate change will likely change rainfall/run-off patterns in the Amazon region (Richey et al. 1989) in ways that require policy attention to previously unmanaged ES (e.g., surface water flows) and development and deployment of new ES.

⁵ Since policy action can influence some of the elements of this calculus (e.g., investments can increase the effectiveness of a given MO, and hence increase the expected benefits associated with ES management), choosing whether or not to manage an ES is not always independent of MO choice.

⁶ Cost-effectiveness is a fundamental criterion for choosing among MO for specific ES tasks, especially for those ES flows for which values cannot easily be established. Other criteria include important indicators of sustainability, such as those identified in the last three columns of Table 3.1.

Table 3.1 Example of the summary criteria for selecting among management options for a targeted ES: carbon retention in Amazon forests

Alternative MOs for Achieving a Given ES Objective (e.g., Carbon retention in the Amazon)	Expected Impact on Targeted ES	Expected Cost of Intervention	Expected Cost Effectiveness	Expected Effects on Poverty	Effects on Non-Targeted Ecosystem Services	
	Tons of carbon retained (tons in year T)	PV of establishment and operational costs (2007 US\$)	Expected cost per expected ton of retained carbon (PV of costs/tons of carbon, 2007 US\$)	Change in income of resource-poor smallholders attributable to carbon retention program (PV of income changes, 2007 US\$)	Enhancements (e.g., measures of plant/animal diversity)	Declines
Payments to farmers for carbon retained						
Forest use regulations						
Cap-and-trade system						

While the framework for MO selection set out in Table 3.1 is conceptually appealing, filling in the cells is an ambitious task beyond the scope of this chapter. Instead, our objective is to identify the types of research and training activities that need be undertaken in order to fill in Table 3.1 for selected ES and to better-position policymakers to use that information. We first provide an overview of MO that address both the causes and the consequences of ES under-provision (section 3.2). Second, this chapter lays out the basic mechanisms through which MO affect human behaviour related to ES flows (section 3.3). Third, we summarize factors that influence the performance of MO with respect to the performance indicators set out in Table 3.1 (sections 3.4 and 3.5). Identification of knowledge gaps helps us suggest MO-specific research and capacity-building needs, some of which may be undertaken by the ESPA Program. Based on what is known about the potential for alternative MO to manage ES flows in the Amazon and Andes, we finally review factors that affect the cost-effectiveness of selected MO (section 3.6).

3.2. The literature review: methods and general observations

We screened over 600 peer-reviewed journal articles, research reports, and institutional publications in English, Spanish, and Portuguese that dealt with MO. We identified 25 types of MO that allowed us to categorize entries according to: regional focus, ES addressed, socioeconomic effects (expected or observed), and approach (empirical, theoretical). Twenty percent of the reviewed articles had an empirical focus on Latin-America (12% Amazon, 5% Andes); 5% and 18%

focused on Africa and Asia, respectively.⁷ For each MO category, key studies were analyzed to learn more about their performance under different agro-ecological and socioeconomic conditions and for managing different ES. Most of the publications dealt with carbon, water-related ES, and plant biodiversity; there were fewer studies of forest products, soil degradation, and air pollution.

Apart from literature on payments for ES, few publications addressed specific and well-defined ES. The ES concept has only recently been widely adopted in the scientific literature; and with the exception of water, few ES-specific policy instruments are available. Many of the early and most cited publications that use the ES concept (e.g. Costanza et al. 1998 or Daily 1997) have focused on providing quantitative and qualitative evidence of the benefits or value to society of ES. As argued in the introduction to this chapter, being able to measure the value of these benefits or the costs associated with foregoing them, is key to making informed decisions about whether, where, and how to intervene and manage ES. A recommendation that will emerge from this review is that more time and multi-disciplinary effort be dedicated to refining and measuring ES.

A few “pure” ecosystem services studies do use the ES concept to analyze causes and possible remedies of reduced and suboptimal ES provision (Sternier 2003). The Millennium Ecosystem Assessment (MEA 2005) provides one of the first, broad frameworks for defining and managing ES. The diverse events and processes (natural and human-induced) that affect ecosystem functioning are termed direct or indirect drivers of ecosystem change that can be addressed by potential responses; the latter being equivalent to what we call MO. We prefer the term “management,” because it better describes the required proactive, multi-stakeholder process of efficiently and equitably managing ES flows.

3.3. Management options: what are they and how do they work?

Options to manage natural resources or ES have been classified in many different ways. Bayon (2001) distinguishes public-good-specific, incentive-changing, and business options. Sternier (2003) divides MO into options to use markets, create markets, regulate use, and engage the public. The MEA establishes categories of response options, such as legal, economic, and social responses.

Classifying MO requires somewhat artificial conceptual boundaries. MO may use different mechanisms to achieve similar objectives and they can be applied by different actors at multiple spatial scales and in different socioeconomic contexts. Our typology of MO (introduced and explained below) does not aspire to improve on previous classification attempts; but rather provides a didactic tool for subsequent analysis of ES management options in settings where poverty alleviation is a key policy objective.

Despite differences among conceptualization of MO, all policy instruments for environmental management seek to influence human behaviour. Ideally, a decision-maker's goal is to use MO to “adjust” human behaviour to achieve socially optimal use or conservation of natural resources (including ES flows) (Baumol & Oates 1988). In practice, decision-makers don't know what this social optimum is; and even if they did, do not know the best MO to achieve it. While we may not know what is optimal, stakeholders do have strong preferences regarding natural resource management and ES flows. Also, market forces alone will not deliver what most stakeholders prefer. MO are necessary; but we need a framework for understanding them and for evaluating among them for achieving preferred natural resources and ES flow outcomes.

⁷ The remainder of the articles focused on developed country settings or problems, or were not specific to any geographic region.

A first step in doing so is to identify three basic (and admittedly not strictly exclusive) ways or mechanisms through which MO can affect human behaviour:⁸

- Establishment of general conditions that enable behaviour driven by private incentives to contribute to achieving a given ES objective (Enablement)
- Provision of (specific) incentives that change behaviour in ways that contribute to achieving a given ES objective (Incentives).
- Provision of (specific) disincentives that change behaviour in ways that contribute to achieving a given ES objective (Disincentives)

Figure 3.1 summarizes MO identified by our literature review according to these three categories.

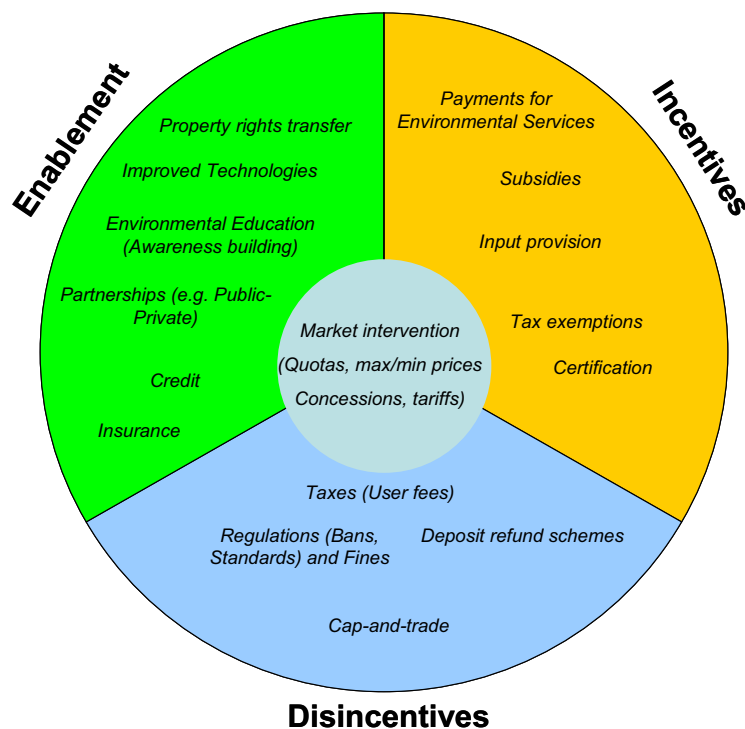


Figure 3.1 Basic management option mechanism for affecting human behaviour: enablement, incentives, and disincentives

Enablement MO

“Enablement” MO contribute to conditions in which it may be in an individual’s, a household’s, or a community’s interest to use or modify a given ES in socially optimal ways. These MO can promote desirable ES outcomes that would emerge if behaviour was not constrained by private interests.

⁸ We emphasize the word ‘can’ because the intensity with which a given MO is used and the duration of use of a given MO will, in part, determine its effect on human behavior – e.g., small price subsidies and short-term punishments may do little to change behavior.

For example, private entities cannot be expected to produce agricultural technologies with large public-good components or provide environmental education.⁹ Although both MO (technology development and education) may enable farmers to improve ES management, investment in them will not guarantee more socially acceptable ES outcomes (e.g. reduced erosion from agricultural land, see section 2.6).

Enablement MO are generally unlikely to remove all constraints that preclude the desired human behaviour (e.g., credit provision may not be sufficient to overcome resource overuse due to insecure land tenure). In a less-constrained situation an individual may choose behavioural options that do not involve the targeted ES (e.g., credit provided for soil-enhancing investments may instead be used to pay for children's education). Nevertheless, MO in this category can contribute to more efficient and socially optimal ES use or to less damaging ES modifications (Kuyvenhoven 2004). Enabling MO are often viewed as complementary policies needed for effective implementation of some incentive and disincentive MO (Auty & Kiiski 2002). Because enabling MO by definition and design aim to increase options available to the rural poor, they can have negative effects on ES use or flows, e.g., providing rural credit in forested areas can increase deforestation (Vosti et al. 2002).

A frequently cited example of an enablement MO is the transfer of natural resource property rights to local resource users or to lower-level administrative units (Agrawal & Gupta 2005). Poorly defined or non-existent property rights, resource tenure insecurity, or open-access motivate natural resource "mining" strategies or the rapid exploitation of ES in the face of uncertain opportunities for future use (Hotte 2001; Schuck et al. 2002).

Economically competitive and environmentally friendly **alternatives** to traditional technologies will likely be adopted without specific incentives that encourage their use or disincentives that discourage the use of environmentally more damaging technologies (Qaim et al. 2006). If, however, access to such technologies is limited by liquidity constraints, MO such as rural credit schemes have shown increased adoption rates and ES use efficiency (Anderson et al. 2002; Anderson & Thampapillai 1990).

Government and civil society engagement in **environmental education** and **awareness building** is a major contributor to reducing the costs of environmental management by affecting human behaviour in ways that narrow the gap between privately and socially optimal ES flows (Kollmuss & Agyeman 2002; Palmer et al. 1998).

Relatively small investments in mutually beneficial **partnerships** can help solve environmental problems (Schwartzman & Zimmerman 2005), although implementing this particular enabling MO often requires long-term coordination, and the establishment and maintenance of a legal regulating framework (Visseren-Hamakers & Glasbergen 2007), all of which can be expensive.

Farm income (i.e., human welfare) and some types of ES flows are directly and negatively linked. Excessive rainfall can cause flooding that destroys crops; or droughts can make agriculture unfeasible. **Insurance** schemes have traditionally been used to mitigate negative effects related to extreme weather events (Hazell et al. 1986). The public sector has played important roles in establishing, monitoring, and guaranteeing such schemes. In situations in which risk undermines the incentives to adopt ES-friendly technologies or farming practices, insurance schemes can contribute to stabilizing or increasing incomes, and to ES conservation (Nail et al. 2007).

⁹ For a list of reasons why the private sector will not provide the needed goods or services, see Belli et al. (2001), Technical Appendix.

Incentive-Providing MO

Where given ES are underprovided, overused, or underinvested in, the value of that ES may not be evident to or captured by individuals affecting their provision. Governments have often provided direct incentives that encourage ES conservation (Portney & Stavins 2000). **Subsidies** have been among the most frequently used incentive-providing MO--e.g., in the European Common Agricultural Policy and in some Latin American countries (Huber et al. 1998; Lowe et al. 1999). Europe has long guaranteed its farmers cheap access to credit and inputs. Unfortunately, subsidies for intensive ES uses can contribute to ES losses--e.g., water for agriculture or forest clearing for agriculture (Brouwer & Lowe 2000). **Input provision** and **tax exemptions** are ways of providing indirect subsidies for the provision or protection of ES. Yet, providing inputs below market prices can damage existing markets and targeting tax exemptions can be difficult for ES that are hard to monitor. Nonetheless, these policy instruments could be used, perhaps in combination with other MO, to change behaviour in ways that generate or protect ES (Oenema et al. 2006).

Payments for environmental services (PES)¹⁰ are generally perceived to be the most direct way to stimulate the provision of a given ES. Albeit with few concrete examples, PES has received much recent attention (Börner et al. 2007; Wunder et al. 2008). Costa Rica was one of the first countries to implement a national PES scheme to manage ES such as biodiversity, soil erosion, water flow, and forest carbon stocks (Pagiola 2007). Effectiveness, cost-effectiveness, and equity effects of these pioneering projects have yet to be comprehensively assessed; and the context-specific factors that are likely to influence these indicators of MO performance not yet been identified or carefully studied (Pagiola et al. 2005; Wunder 2007). In the Andes, watershed PES schemes are mushrooming, partly because transaction costs of reaching agreements are lower in well defined watersheds with up-stream ES modifiers and downstream ES users (Southgate and Wunder 2007). In the Amazon, few PES-like schemes exist, and large-scale applications are limited by poor information on tenure rights of ES providers (Wunder et al. forthcoming).

Certification or eco-labelling is a widespread MO used to increase the market prices of products produced in ways that are less environmentally damaging, and hence provide incentives for implementing ES friendly production practices (Ferraro et al. 2005). The certificate separates markets for conventional and more eco-friendly products and allows consumers to pay (a premium) for the improved management of ES. Some refer to certification as market creation MO (Nunes & Riyanto 2001). Costs of establishing and managing certification and eco-labelling schemes need be included in the analysis undertaken to select the proper MO for managing a given ES or set of ES.

Disincentive Providing MO

Disincentives are the most commonly used policy instruments for environmental management, especially in the Andes/Amazon neighbour countries (Huber et al. 1998). When costs associated with ES use or modification are perceived by society to be excessive, disincentives can be used to reduce and regulate activities causing ES losses. MO such as **regulations** (e.g., forest retention laws), **bans** (e.g., trade bans on endangered species), and **standards** (e.g., sex and size restrictions on the harvesting of certain types of wildlife) are examples for command-and-control MO. Fines and legal action (e.g., imprisonment) are generally used to enforce compliance (Pearce & Turner 1990). Command and control MO have been largely criticized as being economically inefficient and as having negative effects on poverty (Dietz et al. 2003; Holling & Meffe 1996). They are popular among decision-makers in part because they are relatively easy to establish--though

¹⁰ The "environmental services" addressed by most existing PES schemes are equivalent to ecosystem services with public good character, e.g. carbon fixation and biodiversity related benefits, or scenic beauty (Landell-Mills and Porras 2002).

less easy to enforce (Huber et al. 1998) and because they can generate government revenue in the form of fines.

Huber et al. also highlight that the revenue-generation of **environmental taxes** is a reason that this MO has been preferred by public policy decision-makers. Whether this revenue is enough to cover costs of enforcement and of MO management is an open question given that governments generally need to borrow to establish such programs. Environmental taxes in developed countries can bring about both ES and welfare gains (Bosquet 2000; Johnstone & Alavalapati 1998). In the context of developing countries, however, levying taxes to enhance ES flows may have negative welfare effects (Bruce & Ellis 1993) unless poor ES modifiers do not receive special treatment, e.g., tax exemptions.

User fees are an option for managing local ES use and modification, e.g., in national parks and **protected areas** (Green & Donnelly 2003). User fees in the form of resource extraction permits are a form of regulating resource use and extraction and hence of ES such as water use and timber extraction within and outside of protected areas (Simula et al. 2002; Sudirman et al. 2005). Properly enforced, protected areas (PA) are the purest form of natural resource and, hence, ES conservation. Large economic benefits can be derived from allowing some access to and use of PA, especially if PA are successfully integrated in local and international markets for tourism and other non-destructive uses (Amend et al. 2006). Whether PA achieve conservation objectives, however, depends on effective enforcement. Whether PA can cost-effectively achieve conservation objectives requires analysis of establishment and management costs. Hayes (2006) shows that for a large sample of PA, effectiveness in achieving conservation objectives is not necessarily higher than the effectiveness of other types of forest protection. Involving local populations in the design of use-and-protect strategies for PA has been found to be effective (cost-effectiveness is generally not addressed) and equitable (Cernea & Schmidt-Soltau 2006).

3.4. Factors influencing performance of MO in achieving defined objectives

The MEA approach to classify ES in terms of regulating, provisioning, and supporting services is useful to understand how ES contribute to human well-being. More specifically, it helps identifying pathways through which ES benefits accrue to particular stakeholders, thereby helping to determine who could and should cover at least some of the costs of the MO. From a management point of view, however, the MEA categorization may be less convenient because it groups ES with very different characteristics in the same categories. In fact, understanding implications of specific ES characteristics for management has been considered crucial to designing suitable intervention strategies (Kroeger & Casey 2007).

Choosing among MO requires the definition of specific development objectives. As suggested in Table 3.1, if the objective is to enhance or maintain the provision of a given ES, the abilities of alternative MO to deliver improved ES flows in cost-effective ways should be evaluated. Likewise, effects on secondary objectives, such as poverty alleviation and provision of non-targeted ES should be considered. Both, ES characteristics and the context in which MO are applied are factors that influence the performance of MO in achieving these objectives. In what follows, we highlight the most relevant of these factors.

Excludability

Certain MO can be discarded, including most featuring incentives and disincentives when the ES of choice has attributes of a private good. An ES has private good characteristics if beneficiaries can exclude others from reaping the same benefits. Forest products or soil quality on private land are

excludable ecosystem goods/services that, if extracted/used, provide benefits only to landowners.

Whether users of ES with private good characteristics can exclude others from deriving the same benefits generally depends on resource ownership or use rights (Ostrom et al. 2005). In both the Andes and the Amazon, many natural resources are, *de facto*, open access with ill-defined, incomplete, non-existent, or incompletely-enforced property rights (Ravnborg & Guerrero 1999; Seroa da Motta & Ferraz do Amaral 2000). Weak infrastructure and administrative capacities in developing countries limit the effectiveness of disincentive-based MO in these situations, because the effectiveness of such MO, too, depends on proper enforcement. This holds in particular for large part of the areas that section 2.7.1.2 identified as important for forest product provision. Also incentive-based MO for private good ES, such as PES schemes, are generally hard to justify because ES flow benefits are primarily local.

Swinton et al. (2003) found, for the case of Latin America, that ES with private good characteristics are subject to overuse if users lack the means (or opportunities) to invest in their maintenance or efficient use. In such cases, disincentives (e.g. taxes or fines) could well increase poverty. Enabling MO, such as property right transfers and supporting local communities to build efficient institutional arrangements that regulate resource use and access, are promising candidates to address such situations (IFAD 2003; McGrath et al. 1993).

That said, extracting forest products or ill-managed soils can produce externalities affecting ES with public good character, such as habitat quality reduction (section 2.1.1.1) or soil erosion (section 2.6.2). Carbon stock increases, too, are a classic example of a non-excludable (i.e., public) ES: benefits of carbon retention and fixation accrue to the society as a whole and not exclusively to the individual even if the individual owns the land. Hence, incentives for landowners to increase or maintain carbon stocks are adequate options if society feels these services are underprovided.

Finally, excludability has important implications for the ways in which ES management may contribute to alleviate poverty. If benefits of ES with private good characteristics can be captured locally, MO that enhance their provision will increase well-being of poor ES users (not necessarily modifiers). For instance, measures to reduce freshwater pollution from mining and urban settlements will benefit downstream water users. On the contrary, MO to reduce carbon emissions from deforestation (i.e. maintenance of ES with public good characteristics) will bring about few local benefits for the poor, unless they own land and are duly compensated for the forgone benefits of converting forests to other land uses.

The biophysical characteristics of ES

The MEA definition of ES comprises all sorts of benefits provided by ecosystems. Understanding some of the basic biophysical properties of individual or bundles of ecosystem services and goods is necessary to evaluate the potential costs and effectiveness of MO. Here we concentrate on ES interdependencies as well as temporal and spatial dimensions of ES provision.

Not all ES are equally “systemic”, i.e. dependent on other specific ecosystem conditions and processes. Carbon fixation in plants, for example, is a universal process. Although it depends on climate and soil conditions, few other specific ecosystem components need to be in place for plants to sequester carbon. The presence of endemic species, such as fish or terrestrial wildlife, on the other hand, often depends on specific (sometimes unknown) habitat conditions (see section 2.7.1.1). That said, in natural forest ecosystems, many important ES are directly linked to forest cover, albeit not necessarily dependent on each other.

Biophysical independence has made it easier to quantify and predict ES stocks and flows in land use systems, and to identify and test policy approaches to managing ES (primarily carbon) in the

context of forest and in agro-ecosystems (Pagiola et al. 2002). In many cases, land cover is an acceptable indicator for above-ground carbon stocks, which is convenient from a management point of view. As indicated in section 2.3, water flow quantities and related ES are relatively independent from land cover (at least in the Amazon), but knowledge about basin characteristics and climate conditions inside and outside the actual ecosystem have helped to predict also this ES quite accurately (Schöngart & Junk 2007).

Apart from interdependencies, ES provision varies over time and delimited space (Kremen 2005). Rivers reach the ocean where they largely cease to influence land ecosystems. Elevation and associated climate in regions such as the Andes introduce spatial variations in provision of ES. In the Amazon where elevation is of much lesser importance, basin, bedrock characteristics, and tidal inundation introduce spatial variability to ES provision. For example, tidal movements in the Amazon allow for electricity generation in small-scale tidal power plants along some, but not all, rivers and temporally inundated areas (Charlier 2003).

Often there are also multiple temporal patterns to ES provision – diurnal, monthly, seasonal, and inter-annual. Diurnal temperature variations affect the crops that can be grown. The discharge of the Amazon has been shown to vary enormously depending on the ENSO cycle, with implications for hydropower generation, fluvial transport, and fisheries (Richey et al. 1989). If relevant, these natural patterns should play a role in decision-makers' choices of MO as well as the details associated with selected MO (e.g., whether or not to offer payments for maintaining or enhancing ecosystem services, and if so, how payments affect temporal patterns of ES provision).

Space and time can induce uncertainty regarding ES flows.¹¹ We may not know where the endpoint of influence of a particular stream flow might be at a given point in time because rainfall in a given year can extend or reduce that stream's flow. Some uncertainty can be reduced with investments in research/monitoring. Although decision-makers seeking MO for specific agro-ecological and socioeconomic circumstances may meet objectives "on average", there will be times and places when/where MO will over- or undershoot the objectives. MO selection and crafting may alter the amount of over- or undershooting, and time/effort spent doing so may contribute to the institutional sustainability of the selected MO.

Implications for management

Excludability of ES benefits is relevant for choosing the right category of MO. Direct incentives, such as PES and subsidies require threats to public ES benefits to be justified. If ES benefits are private and primarily local, ES loss is probably due to conditions that disincentives are likely to aggravate, e.g. insecure property right, conservation investment poverty or limited access to technological alternatives. MO that enable ES modifiers to use ES more efficiently seem to be a sound way to address such situations.

ES interdependence is relevant when MO are designed to target specific ES as opposed to bundles or higher units of management, such as forest cover or entire ecosystems. Managing individual ES can cause undesired side-effects on other ES if interdependencies are not well understood or externalities affect other ES, e.g. ground water pollution from forest plantations to boost carbon fixation. Likewise, hydroelectric dams affect not only water flow volume and speed, but also related ES, such as aquatic biodiversity and sediment flows downstream. "No touch" MO, such as strictly protected areas are therefore standard MO to address interdependent and hard to measure ES, but

¹¹ The same may be true for the value to society of particular ES, e.g., the value of surface water during the wet season can be much lower than the value of surface water during the dry season; we deal only with the issue of uncertainty in ES flows here.

they limit opportunities to capture local ES benefits. During stakeholders consultations (see Chapter 5) it was repeatedly suggested that individual ES are not necessarily the best unit of management for ES in the Andes/Amazon context. For example, landscape level management might be better suited to conserve cultural ES, such as recreation and scenic beauty (see example 4 in table 4.3 in the next chapter). This is mainly, because it is not readily clear, which specific components of the ES providing environment make up its value to users.

Spatial and temporal dimensions of ES provision are relevant, because humans adapt to (and derive benefits from) them in different ways. Hence, rapid and unexpected changes (e.g., due to policy or climate change) can imply huge costs to those dependent on the affected ES. The 2005 drought in the Amazon magnified the implications of water shortages to the local and regional economies that have developed under conditions of relative water abundance (Zeng et al. 2008).¹²

Climate change and human-induced land cover change in the Andes/Amazon region can increase the complexity of measuring and managing ES with strong systemic linkages, such as biodiversity-related services and services related to water flows. It also alters the ecological determinants of non-systemic ES provision, such as carbon retention in forests, e.g. through increased fire susceptibility of moist forests.

Natural temporal and spatial ES flows are being altered by human activities to harness ES benefits (e.g., diverting rivers for irrigation) or to reduce associated damage from ecosystem disservices (e.g., levees for flood protection). As opposed to climate-related impacts, such efforts are driven by the economic returns to ES flow modification, which, too, tend to follow spatial patterns (Chomitz & Thomas 2003; Pfaff 1999; Thünen 1826, see also next section).

Hence, spatial and temporal dimensions of ES flows and benefits and associated uncertainties matter to decision-makers that are faced with choices between MO. Managing ES is further complicated because beneficiaries of ES flows are often separated (in time and space) from ES modifiers. A first step towards managing a given ES therefore is to understand how the (natural) characteristics of this ES and its use and modification affect:

1. the types of net-benefits¹³ that the ES provides,
2. the ways in which these benefits are generated,
3. the temporal and spatial scales at which benefits are generated, and
4. to whom, where and when these benefits accrue.

The second step is to ask how alternative MO may affect these four items.

In practice, managers may not have the means to measure actual ES flows, e.g., those flowing from different compositions of plants in a given locale. Hence, decision-makers are often forced to manage land uses (or other broader units that are relevant for ES provision) in the hopes of influencing specific ES flows. **Figure 3.2** depicts a method for managing ES through land uses. First, ES flows are identified (ES1) although often not well-measured (e.g. pollination). Second, land uses (e.g., for maintaining bee populations, Land Uses 1) likely to generate these flows are promoted. If policies are successful in promoting these land uses (Land Uses 2), it is assumed that

¹² "Record drought cripples life along the Amazon". New York Times, December 11th, 2005.

¹³ It is important to note that not all ES flows necessarily generate only benefits; e.g. floodwaters often imply cost, and, the value of additional stream flow (once requirements are met) might be zero or negative.

this success is proportionally replicated for all targeted ES (ES2). A problem is the extent to which heterogeneity within land uses affects flows. Although a forest use regulation and a cap-and-trade system may be equally effective in retaining a specific total amount of forested land, the geographic distribution of the forests generated by the two MOs and consequences for ES, such as habitat quality, will likely differ (Debinski & Holt 2000).

In fact, decision-makers are often forced to manage ‘bundles’ of ES via decisions that affect land use and land use change. Conserving ES ‘bundles’ may be a way to piggy-back some unknown, immeasurable and/or highly undervalued ES. Yet, bundling may just as well include low value ES, which could be compromised in exchange for local income generation. Efforts are being made to un-bundle ES and to determine the social value of doing so—with part of the value added stemming from a greater ability to choose more cost-effective MO capable of focusing on specific ES.

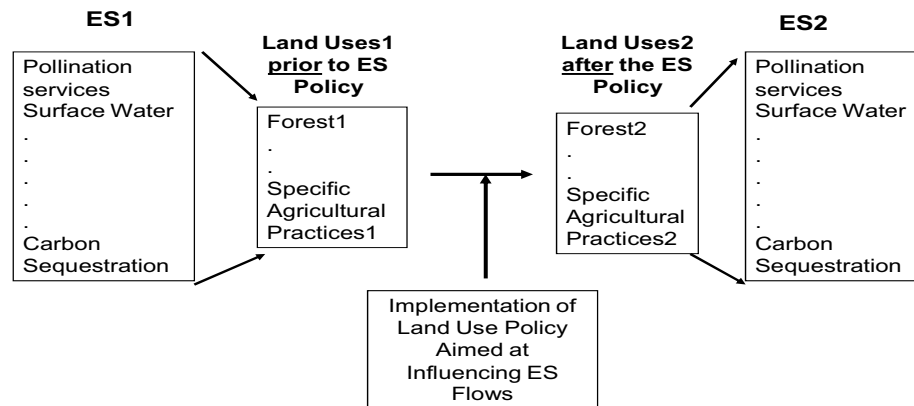


Figure 3.2 Managing ecosystem services via management of land use

Other factors affecting choice of MO

A series of factors unrelated to ES characteristics can affect expected indicators of MO performance set out in Table 1. We begin with a discussion of socioeconomic factors and then focus attention on institutional factors.

Socioeconomic factors can influence the willingness and ability of individuals or groups to engage in efforts that change the flows of ES and can affect achievement of ES objectives relative to particular MO. Key factors are size and timing¹⁴ of flows of private benefits derived from ES-flow-modifying activities and investments that come in the form of increased expected profits and asset values, or both.

Expected profitability of ES modifying activities is affected by access to transportation, technology and information. Yet, how these factors affect ES flows is site- and ES-specific. Although road construction in the Amazon generally leads to deforestation and related ES losses, investments in transportation and other infrastructure are ways to promote sustainable agricultural intensification that can reduce ES losses over time (Zaal & Oostendorp 2003).

¹⁴ Timing is important because the flows of benefits and costs associated with specific activities and investments are discounted to account for time preference, and the discount rate can be high for resource-poor economic agents.

The type (increased profits or asset values), size, and timing of the net benefits associated with ES flow-modifying activities and investments, and the stakeholder groups to whom these benefits accrue, are relevant decision variables for MO selection. Where such activities and investments are very profitable (e.g., forest conversion for soybean production), PES schemes will be expensive and perhaps beyond the willingness to pay of ES beneficiaries. Land use taxes (that reverse financial flows among stakeholder groups, vis-à-vis PES) or land use regulations may be more cost-effective even if enforcement/monitoring costs are included.

Finally, the presence poverty itself should affect MO choice. This is where the different concepts and measures of poverty discussed in the introduction come into play. The low-income poor may or not be hurt by MO that establish disincentives, such as fines or user fees, for local private ES use or global public ES modification. It will depend on the degree to which these poor stakeholders depend on using or modifying these ES. Most standard poverty measures do not capture these dimensions and are, hence, of limited use for such kind of evaluations. As shown in Chapter 2, existing data allows us to show where these low-income groups are located and to characterize (at least in rural areas) the general state of some local life supporting ES in their environment. However, it is not at all clear whether low-income groups can actually benefit from these ES, especially if access is related to land tenure and property right issues (see also below). A general lack of such information in the Andes/Amazon context represents a serious limitation for regional assessments of the ES dimension of asset-based poverty (see section 1.1).

Conservation investment poor, on the contrary, may be better off paying small user fees or taxes, than having to follow strict environmental regulations that could discourage innovative land use practices and technologies with associated ES benefits (Börner et al. 2007). Such groups often practice hillside agriculture (Andes) or small-scale slash-and-burn farming (Amazon); i.e., production systems often characterized by low opportunity costs of ES provision, which makes them theoretically viable targets for PES schemes.

MO that enable ES users and modifiers to deal with ES more efficiently, if this is in their own interest, are a sound way to address poverty. To achieve this, existing technologies sometimes need to be adapted to specific conditions; or new and competitive technologies for more efficient ES use have to be developed. Obviously, addressing poverty requires other non-ES oriented interventions as well, e.g. basic education and other public services.

Institutional factors affect the profitability of ES efforts and, thus, the cost-effectiveness of MO. Law enforcement and the definition and security of property rights are basic preconditions for the effectiveness of many MO. Regulations will usually not be followed if the benefits of non-compliance outweigh the costs. The same applies to taxes and other MO from the “disincentives” category in Figure 3.1. Lack of the “rule of law” also can affect “incentive” MO: PES schemes may be ineffective if the recipients (e.g., landowners, in this case) cannot exclude others from modifying services deriving from their land. PES may actually support property right enforcement by rural communities and, overall, lead to positive environmental and welfare outcomes (Engel & Palmer 2008).

Other MO, such as community-based resource management, require collective action, civil engagement, and organizational capacity (Kellert et al. 2000). Yet, social capital in recently-settled areas such as the forest margins is typically lacking and investments in social capital building MO can take time to yield desired results (Fearnside 2001). The potential for building social capital is enhanced if those who modify ES flows can communicate and negotiate with users and if the benefits of negotiating outweigh transaction costs of doing so (Lubell et al. 2002). Promising are cases with clearly defined ES benefits and well known groups of ES modifiers and users, e.g., small watersheds with upstream water modification and downstream water use. As May (1991) notes, both poverty and spatial dispersion of beneficiaries of a particular ES flow often reduce the visibility

of ES-welfare relationships, and thus limit both private and policy responses to ES management.

Local problems often require local solutions. Governments have delegated management of some natural resources (and hence ES) to lower-level administrative units, such as states or districts. Decentralized management, however, poses new challenges to ES management, among them the risk that unprepared and underfinanced local governments lack needed administrative and technical capacities (Toni & Kaimowitz 2003). According to official statistics, roughly 30% of municipalities in the Brazilian Amazon do not have environmental secretariats in their local government structure. In those that do, there is an average of 0.6 staff available per square kilometre of average annual forest loss. Both, limited infrastructure and poor capacities for national and international articulation mean that only 13% of municipalities can raise funds for their environmental agenda.

To conclude, even if local governments and local civil society are prepared to cost-effectively handle local ES flow management challenges, such challenges are generally not exclusively local, but rather 'spill over' spatially and temporally into the domains of other decision-makers. Some very important ES flows with large public good components do not coincide with, or are contained within, administrative boundaries, and managing them therefore requires cooperation across policy-making boundaries. In the Amazon and Andes this applies especially to water and biodiversity (fauna) related services. In the respective countries the need for cooperation has given rise to the foundation of the Amazon Cooperation Treaty Organization (ACTO). However, multilateral environmental agreements and partnerships around the world are plagued with the same difficulties that arise at local level, e.g., free riding (individuals, communities or even countries reaping the benefits of ES management without paying their share of management costs) and high transaction costs of inter-governmental negotiations (Chang & Rajan 2001).

3.5. MO for ES in the Andes/Amazon region, and their expected effects on poverty

This chapter does not provide a recipe for selection of specific MO to meet specific ES flow objectives under particular agroecological or socioeconomic conditions. Rather, we provide insights into factors that should influence such decisions and suggest research priorities to fill knowledge gaps. In this section we look at selected existing and promising MO and highlight specific conditions in the Andes/Amazon context that are likely to affect their cost-effectiveness in addressing both poverty and ES objectives in the region.

Table 3.2 summarizes these conditions for each MO. Column 1 identifies the class of MO. Column 2 identifies the ES to be managed. Column 3 identifies necessary conditions for poverty-neutrality. Column 4 identifies factors that can reduce MO's potential to alleviate poverty; and the final column (5) examines factors affecting the cost-effectiveness of a given class of MO in achieving ES management objectives. The factors mentioned in the table are not meant to be universally valid. Instead, they point to conditions that prevail in significant parts of the Andes/Amazon, but that may not be relevant in others.

Beginning with Column 2, it is clear that most MO can be used to address ES flows associated with either specific ES or bundled ES. In practice, however, the great majority of MO have been used to influence human behaviour with respect to broad natural resource categories--such as forests or fisheries--with expected but most often unmeasured direct effects on specific ES flows. The exception are PES schemes designed to address one or two well-defined ES, such as carbon or biodiversity related services, but which likely have spill-over effects (of different magnitudes and perhaps in different directions, vis-à-vis the targeted ES) on other ES.

Table 3.2 MO and factors that influence their potential cost-effectiveness and poverty impacts in the Andes/Amazon

MO	ES Target	Conditions for potential to reduce (or not exacerbate) poverty	Factors that reduce MO potential to alleviate poverty in the Andes/Amazon	Factors reducing cost-effectiveness in achieving ES objectives in the Andes/Amazon
PES (Subsidies)	Specific <ul style="list-style-type: none"> - Carbon - Biodiversity - Water - Scenic beauty 	<ul style="list-style-type: none"> - If the poor can offer additional ES provision - If the poor have effective rights to exclude others from modifying ES 	<ul style="list-style-type: none"> - If poor can offer little additionality - If poor have weak, insecure property rights - If costs of achieving participation are high 	<ul style="list-style-type: none"> - High opportunity costs - Spatial heterogeneity of opportunity costs - Institutional inefficiency
Taxes (user fees, etc.)	Specific and unspecific <ul style="list-style-type: none"> - Timber - NTFP - Water - Carbon - Biodiversity - Scenic beauty - Climate regulation 	<ul style="list-style-type: none"> - If tax revenues are reinvested in (compensating) poverty alleviation measures or - If the poor can directly capture the revenues or - If the poor are excluded from tax 	<ul style="list-style-type: none"> - If poor are allowed to capture user fees they may lack capacity to attract users - If poor are highly dependent on ES subject to taxes 	<ul style="list-style-type: none"> - Weak enforcement capacity - High transaction costs (monitoring and enforcement)
Certification	Specific/unspecific <ul style="list-style-type: none"> - Water/Air quality - Carbon - Biodiversity - Soil quality - Climate regulation 	<ul style="list-style-type: none"> - If the poor have market access - If the poor can capture price premiums, and - If the poor can meet quality standards 	<ul style="list-style-type: none"> - Limited market access - Limited potential for economies of scale to reduce certification costs - Costs of investments into technology 	<ul style="list-style-type: none"> - High transaction costs (monitoring of difficult to measure ES) - Weak enforcement capacity
Technological Innovation	Specific and unspecific <ul style="list-style-type: none"> - Various 	<ul style="list-style-type: none"> - If poor have technology access (knowledge, extension, infrastructure) - If the poor can afford up-front investment costs 	<ul style="list-style-type: none"> - Limited technology access - Conservation investment poverty - Information and skill asymmetries 	<ul style="list-style-type: none"> - High opportunity costs of conservation investments - High development costs (R&D system)
Regulation (bans, standards, protected areas)	Specific and unspecific <ul style="list-style-type: none"> - Various 	<ul style="list-style-type: none"> - If regulations do not affect essential ES consumption (or if so, compensating mechanisms are in place) or - If regulations include special treatment of poor ES users 	<ul style="list-style-type: none"> - Low bargaining power to negotiate compensation and special treatment 	<ul style="list-style-type: none"> - Weak enforcement capacity - High transaction costs (monitoring and enforcement) if under pressure
Local Institutional Arrangements (community-based resource management, partnerships)	Specific and unspecific <ul style="list-style-type: none"> - Various 	<ul style="list-style-type: none"> - If the poor have equal bargaining power in the negotiation process - If institutions are set up in a way that promotes poverty alleviation 	<ul style="list-style-type: none"> - Low administrative, organizational capacity of local governments - Low bargaining power - Few cooperative experiences 	<ul style="list-style-type: none"> - High returns to free riding
Environmental Education	Specific and unspecific <ul style="list-style-type: none"> - Various 	<ul style="list-style-type: none"> - If the poor have access to education (infrastructure, costs) and - If education addresses ES issues relevant for the poor 	<ul style="list-style-type: none"> - Low level of teacher training in rural schools - High costs due to poor transport infrastructure 	<ul style="list-style-type: none"> - High returns to environmentally damaging behaviour (lack of rule of law)
Cap-and-Trade Schemes	Specific <ul style="list-style-type: none"> - Air quality - Climate regulation - Various others 	<ul style="list-style-type: none"> - If the poor are sellers and - If the poor have market access 	<ul style="list-style-type: none"> - Limited market access 	<ul style="list-style-type: none"> - Weak enforcement capacity - High transaction costs (monitoring and enforcement)

Designing and implementing MO to achieve poverty-neutrality or to reduce poverty generally implies additional costs (e.g., those associated with building participatory or institutional capacity), thus reducing cost-effectiveness from an ES point of view. Hence, few decision-makers have been willing to incur these costs. Perhaps more importantly, an adequate measure of poverty has to be defined that captures the relevant dimensions of poverty in a given ES management context.

In general terms, poverty effects vary across categories of MO and stakeholder contexts. Poverty effects of “enabling” MO (e.g., technological innovations) depend on whether the poor will be able to reap benefits of ES management. If access to alternative technologies is limited, the poor generally do not benefit and may even become poorer as non-poor adopters’ effects on (say) product prices are felt. The poor may also lack experience, skill, and bargaining power, limiting their ability to effectively participate in the MO. In the case of “disincentive” MO, interventions need to be designed in ways that leave the poor unaffected. “Incentive” MO (e.g., PES), on the other hand, often require a minimum level of participation in markets to work effectively. Conservation payments to subsistence farmers make little sense if there are no or only distant markets that provide staple foods to complement production losses. In the case of ecolabelling, mechanisms are needed to ensure that price premiums actually trickle down to the poor instead of being captured by intermediaries--as has been the case for some certification schemes (Harris et al. 2001).

Finally, given that poverty has different characteristics, poverty effects of the same MO may be different across stakeholder groups. Urban poor are less affected by restrictions on land use or the establishment of protected areas. Such MO may matter most to landless rural dwellers that depend on open access resources, but also to rural colonists if they affect their share of land available for agriculture (e.g., the Brazilian forest retention standard). Likewise, policies that affect prices for basic goods (e.g. energy or gas taxes) may have less impact on rural subsistence producers than on urban low-income groups.

Options for managing ES in the Amazon

The majority of the Amazon region--located in Brazil--is *de jure* highly regulated. Some 41% of the Brazilian Amazon comprises protected areas or indigenous territories. The remaining land is subject to the national forest retention standard that requires 80% of landholdings to remain as primary forest. In practice, however, illegal deforestation continues wherever profitable, mainly along roads and highways (Laurance et al. 2002). Effectiveness of natural resource management objectives requires that “disincentive” MO be strengthened by increased penalties and/or more rigorous enforcement. In many areas of the Amazon enforcement costs are extremely high and eventually less cost-effective than providing incentives such as PES for avoided deforestation, especially in remote areas (Nepstad et al. 2007; Swallow et al. 2007). In theory, PES have the potential to auto-enforce themselves: payments can be simply reduced or suspended if contractual agreements are not met by ES providers. Reality still has to show to what extent this conceptual advantage prevails.

Despite its appeal, cost-effective ES management through direct incentives poses serious challenges. Tradeoffs between development and ES must be addressed in cases where incentives are too costly, i.e. in areas of high agricultural potential (Vosti et al. 2002); and the global community that benefits from public ES must be willing to compensate local actors for lost development benefits in the face of ES maintenance. Moreover, highly concentrated landownership in the Amazon means that effective PES schemes will have to embrace large landowners. This has shown to provoke considerable discontent among equity advocates.

Where property rights are secure, resource use is relatively homogeneous, and communities are willing to cooperate (e.g. in some indigenous or extractive reserves or even in well delimited older colonization projects in the Brazilian Amazon)--building capacities for effective management,

organization and institutional development is likely to help maintain essential ES and to contribute to poverty alleviation. Moreover, rewards for forest stewardship, e.g. through activities that support protection and management of protected areas, represent means to engage local stakeholders in ES conservation with welfare benefits.

That said, virtually all MO to enhance ES provision in the Amazon will have to face a poor state of information on land tenure, with different implications arising from this in each case. Fledgling initiatives to establish decentralized rural property licensing and registration systems require support to increase coverage and become compatible to allow for regional level policy planning.

Options for managing ES in the Andes

Land cover change and subsequent soil erosion in the Andes affects farmers through loss of soil fertility and structure and downstream water users through reduced water quality and quantity. Development of technologies that reduce soil erosion and that protect or re-establish riparian vegetation have long been favoured by ES managers (Ataroff & Rada 2000; Southgate & Macke 1989; Zimmerer 1993). But, frame conditions need to be favourable for technological innovations to be adopted.

Watersheds can be complex both in terms of hydrologic systems (e.g., size, number of sub-basins, seasonal patterns of surface water flows) and in terms of different ES users and their effects on ES. Hence, community based watershed management schemes seldom emerge on their own. Ravnborg and Guerrero (1999) emphasize the importance of establishing platforms for negotiation between ES users and ES modifiers, and note that mutually beneficial negotiation outcomes sometimes crucially depend on third-party facilitation. In complex settings involving large watersheds and multiple stakeholder groups, transaction costs of setting up such platforms are therefore likely to reduce cost-effectiveness of communal management approaches.

PES schemes have been viewed as a cost-effective option to address watershed-level externalities (e.g., sediment runoff) that reduce ES benefits of downstream users (Landell Mills & Porras 2002). Southgate and Wunder (2007) concluded, however, that most initiatives have not yet reached mature states and that key determinants of sediment displacement are still not well enough understood to effectively trace cause and effect relationships in order to design payment mechanisms. Case studies from the Andes have also shown that PES are unlikely to emerge where downstream water users are poor(er) than upstream ES modifiers or where the combined willingness to pay of small downstream communities for improved watershed services is too small to compensate for opportunity costs of conservation measures upstream (Poats 2007).

Water user fees are a standard MO in watershed management. Revenues should ideally be reinvested in maintaining water service provision. It is, however, not always obvious whether such tax revenues are best invested in improving technology to deal with sediment runoff, in compensating users for maintaining ES flows, or in enforcing regulations that oblige them to do so. No cheap, quick, easy-to-apply, transparent tools for examining trade-offs among such watershed-specific investments are available--although their potential usefulness in policy-making is high. A good starting point is to quantify opportunity costs of ES conservation. For hillside zones in the Colombian Andes, Agudelo et al. (2003) show that conservation opportunity costs differ remarkably depending on both ES or natural resources type and ES modifier category. Livestock rangers had rather low opportunity costs of conserving soils and sequestering additional carbon types, whereas costs were much higher for coffee growers.

As we show in the following chapter, tourism and ecotourism represent a widespread mechanism to harness the benefits of the highly valued cultural ES in the Andes region, where ancient cultural sites are often located in visually attractive settings. The cases under study clearly show positive ES

outcomes as a result of ecotourism. However, Wunder (2000) notes that ES gains depend on whether tourism essentially changes labour and land allocation decisions, which must not generally be the case. Moreover, the economic opportunities of tourism have to be weighted against their potential impacts on cultural integrity in traditional populations.

In general, more spatial heterogeneity in ES provision in the Andes means that uniform approaches to ES management are probably even less appropriate than in the Amazon. Local problems arising from ES modification (e.g. erosion) are arguably more commonplace than in the Amazon. Yet, opportunities for reaping economic benefits of direct use values (e.g. ecotourism) more often coincide spatially with ES modifying activities. Research has spotted some of the conditions that need to be in place to make MO work in different contexts. What lacks is knowledge about where these conditions are favourable in order to cost-effectively integrate promising MO into a regionally consistent ES conservation and poverty alleviation strategy.

Region-wide options for managing ES

Andes and Amazon ecosystems are linked through biophysical processes such as water flow and climate regulation (see spatial analysis in Chapter 2), and through socioeconomic systems such as trade, migration, transport infrastructure, and common cultural territory of indigenous populations. Some biophysical processes are better known than others (e.g., rainfall-runoff relationships in the Andes/Amazon vs. weather-biodiversity relationships). Even for better understood relationships, however, our ability to predict effects of natural or human-induced shocks or disturbances on ES flows is limited. Some researchers predict that the Amazon ecosystem may soon reach an ecological tipping point, which will radically alter vegetation distribution and related ES (Nepstad et al. 2008). Assessing and preventing such scenarios from happening clearly requires regionally coordinated management approaches--based on research that provides a more comprehensive understanding of what constitutes ecosystem stability and the determinants of the human behaviour affecting it (Burgos et al. 1991; Feddema et al. 2005).

Downstream water users in the Amazon are affected by sediment flows due to upstream deforestation or pollution from industry and urban centres. Large-scale investments in reservoirs for hydropower generation may have tremendous effects on both river discharge and migratory fauna and, hence, on downstream ES benefits. Understanding and measuring both ES and poverty impacts of such interventions are necessary to achieve cost-effective, and equitable regional ES management. Filling knowledge gaps will require regional scientific cooperation. Currently, there are few incentives for researchers to collaborate with partners from other Andes/Amazon countries. International scientific cooperation has occurred more in the form of bilateral agreements addressing national rather than regional resource management issues¹⁵. The same is true for inter-governmental cooperation. Common resource management is, however, one of the issues addressed by the Amazon Cooperation Treaty Organization (ACTO), which gives hope for innovative regional responses to common resource management issues. Self-organized regional initiatives of institutions in research and education, such as the Amazon Initiative Consortium (AI) and the Association of Amazonian Universities (UNAMAZ), may provide platforms for the articulation of research and capacity building to support regional policy processes.

3.6. Implications for research, capacity-strengthening and policy

Several fundamental questions have to be addressed if stakeholders in the Andes/Amazon region

¹⁵ The IAI (Inter-American Institute for Global Change Research) and the Iberoamerican Program: Science and Technology for Development (CYTED) are noteworthy exceptions from this rule.

do not like what they see in the context of ES flows or the effects of these flows on poverty. Unfortunately, the knowledge base for addressing such questions is, at present, weak.

First, what is it that stakeholders see in the Andes/Amazon regarding ES flows, poverty, and the links between them?

Chapter 2 provides a snapshot of what science has been able to contribute to answering this question at the regional scale. Although we can measure income-based poverty and its dynamics, knowledge gaps stem from insufficient empirical studies of the poor and the nature of their poverty. Both natural and human-made factors influence poverty. Hence, better knowledge about the relative importance of particular ES flows in causing or reducing poverty, especially in the long term, is needed to justify policies that aim at improving well-being through better ES management.

The scientific base for many ES flows is weak. Some clear cases can be made for rather indirect use values of global ES, such as carbon stocks and the distribution of some endemic species. In these cases research needs to focus on how policies (i.e. PES schemes and other incentive providing MO) have to be designed to make sure these values are internalized at the local scale without excluding the poor from reaping their due share of benefits.

It remains largely unclear, at national and regional scales, where and how many locally valued ES flows contribute to sustaining welfare of vulnerable low-income groups. Case studies, many of which are cited in this and/or analyzed in the next chapter, provide important hints that complement findings in Chapter 2. I.e., fishery is an important economic activity in the Amazon (especially for some low-income groups). It is also highly vulnerable to both climate change and human induced modification of water related ES flows. Hence, substantial local benefits can be expected from investments in water quality and improved fish resource management. In the Andes, cultural ES are threatened by urban sprawl and agricultural expansion, but bear potential to generate more stable income streams to poor rural dwellers.

Such hints are well received by local initiatives and international cooperation when there is potential for replication. Yet, to move forward with ES related policy recommendations at national or regional levels, research needs to focus up-scaling results to have impact on decision-making.

Although progress is being made in framing and understanding issues, our review calls for more scientific effort in discovering stakeholder perceptions. One important priority is to more clearly define and measure ES flows, with particular emphasis on the spatial and temporal dimensions of these flows, and on the sources and associated degrees of uncertainty. Such research must be inter-disciplinary because what people see when they mention ES flows is framed by their value systems and desires to meet basic needs. Links between ES flows and poverty must be better understood, even if this improved understanding may lead us to choose policy measures other than managing ES flows to reduce poverty.

Second, if stakeholders are unhappy with what they see, why is this so and what is the extent of their displeasure?

Answering this requires knowledge of private and social benefits associated with ES flows or costs associated with changes in these flows, how benefits/costs vary across stakeholder, and how society might use these stakeholder-group-specific benefits/costs to help make policy choices. In Chapter 5, we summarize perceptions of key stakeholders in the Andes/Amazon. This consultation has helped to bring up issues that the analysis of existing data on ES and poverty would have overlooked. Nonetheless, policy relevant prioritization of ES management issues needs to translate stakeholder perceptions into objective measures.

An important knowledge gap is, therefore, the lack of methods to measure the benefits associated with particular local ES or of bundles of ES, and how these benefits change as ES flows are altered. To address decision-makers' needs, these methods must consider the site-specific nature and temporal patterns of ES flows and must generate distributions of expected benefit flows that capture the inherent uncertainty associated with most ES flows and their values to society. Work on new ways to establish and manage dialog related to ES flows among stakeholder groups is progressing, and is generally seen as necessary for achieving successful and sustainable outcomes. Large gaps do remain in identifying the most efficient methods of establishing and managing multi-stakeholder interactions and in how to generate and deliver science-based information that is useful to such interactions.

Third, if stakeholders don't like what they see, what *can* be done?

Answering this question requires an understanding of biophysical relationships relevant to given ES flows and how these would be affected by policy action, and an understanding of human behaviour of those using or modifying ES flows and the responsiveness of this behaviour to alternative policy actions. The next chapter and some of the research reviewed here provide important hints on the reasons of success or failure in specific contexts, but the general picture remains fragmented.

Constraints to research progress in this area are the complexity of biophysical relationships and the many, often stakeholder-specific, factors that influence human behaviour. Chief among biophysical knowledge gaps are consequences for non-targeted ES flows of actions affecting targeted ES flows. Regarding human behaviour, progress is being made at the level of individual or household decision-making. However, in the Amazon and parts of the Andes, many of the pressing issues related to ES flows, forest product extraction on open access land, pollution and sedimentation in micro-watersheds, and informal urban and peri-urban settlements must be resolved at the community or higher levels where comparative theoretical and empirical efforts are still insufficient.

Once again, integrated research approaches with comparative elements and potential for up-scaling are needed. When isolated research comes to contradicting results, a common explanation is that the region and its socio-cultural and bio-physical settings are heterogeneous. Although this is a true statement, it does generally not contribute to better decision-making. To answer this and the next question, policy and other decision-makers need to know where heterogeneity matters and how the MO at their disposal, with all their inherent imperfections, can best (i.e. cost-effectively) be integrated into a coherent policy framework.

Finally, if stakeholders don't like what they see, what *should* be done, and by whom?

This is the most relevant pair of policy questions--and one that requires the definition of ES-specific policy objectives, information on the effectiveness and efficiency of alternative management options for meeting these objectives, and information on poverty effects of these MO. In some cases, the answer to the first question will be, "Do nothing, at least for now". In other cases the answer will involve identification of a particular MO for improving a specific ES flow; while in another the answer may involve investing in man-made alternatives to natural ES flows. In all cases, answers to the second question must identify the nature of partnerships required to take action and the division of labour among ES users, modifiers and intermediaries (see figure 1.3).

Given the knowledge gaps identified above, the literature generally provides little guidance to this fundamental pair of policy questions. Continued progress in filling these gaps will eventually help address these questions. Part of this lack is due to the failure to frame research needs in ways that respond to these questions. Establishing a framework focused on addressing these questions will identify new gaps in knowledge as well as innovative ways of using existing knowledge to do so.

Key research issues and questions to be addressed by ESPA: Management options

1. Research on the relative importance of particular ES flows in causing or reducing poverty, especially in the long term.
2. Work to elicit and understand stakeholder perceptions (valuation) regarding ES flows.
3. Research to understand the private and social benefits associated with ES flows, costs associated with changes in these flows, how benefits/costs vary across stakeholders, and how society can use this information to make the right policy choices.
4. Work to understand how ES flows can be affected by policy action and to understand to what degree human behaviour is responsive to alternative policy actions.
5. Identifying the conditions (and their spatial distribution) under which incentive-based MO can be cost-effective alternatives to disincentive-based MO
6. Promote pilot experiences in a comparative framework to determine how enabling MO can be used to increase the capacity of the poor to capture the benefits of incentive providing ES.

4. Lessons learned from the region: Contribution of ES management options to improved well-being

The previous chapter reviewed existing MO and defined key selection criteria for achieving the objectives of enhanced ecosystem service provision and well-being based on the literature. This chapter reviews projects having an explicit goal of managing ES to improve human well-being. We discarded projects that enhance ES unintentionally, e.g., those that focus on increasing productivity of crop production and thereby improve soil capacity to retain water and nutrients. Reviewed projects dealt with innovative approaches to conservation and recuperation of ES and their contribution to well-being. The chapter is structured as follows: Section 4.1 introduces the case studies, shows to which MO category each belongs, and lays out the components used for the review. Section 4.2 uses six criteria to examine the case studies from the perspective of their impact on ecosystem services and well-being. Section 4.3 evaluates the case studies' potential for up-scaling (replicability) and assesses cost-effectiveness (see also previous chapter for why this is necessary). Based on the analysis of the case studies, section 4.4 evaluates the potential of ES management options to reduce poverty and increase environmental sustainability in the Andes/Amazon region. Finally, the main messages and priority research issues for the ESPA programme are presented.

4.1. Management options and ecosystem services

Case study projects were selected and reviewed according to MO shown in Table 4.1. Most of the projects employ MO that fit into the group of "incentive-providing" MO, as presented in Chapter 3: those characterized by the provision of (specific) incentives that change behaviour in ways that contribute to achieving a given ES objective.

Table 4.1 Management options used in selecting and reviewing case studies

Project/Programme (MO) type	Ecosystem service provided ¹⁶
Extractive reserves (D + E)	Non-timber and timber forest products
Forest management certification (I)	Timber products
Fair trade certification and organic certification (I)	Crop production
Commercialization of non-traditional products (I)	Non-timber products
Ecotourism (I)	Landscape beauty - recreation
Conservation of goods and cultural services (I + D)	Cultural services
Carbon credits from reforestation or avoided deforestation (I)	Carbon stocks
Payment for environmental services – for hydrological services by means of conservation of forests (I)	Water regulation and water quality

I = incentive providing; E = enabling; D = disincentive providing

¹⁶ As justified by the project. However other services could be bundled

Twelve case studies were reviewed according to the components presented in Table 4.2. The table consists of a structured framework presenting the baseline information needed to assess case studies' performance in terms of ES and well-being. The selected projects are prominent in the region. Some of them are well known because of their contribution to conservation of ES and ecosystems, their impact on well-being and poverty, and/or because they are innovative, unique or simply because they are well promoted. A widespread limitation was that many ES-focused projects are still in initial stages of implementation and provided limited lessons learned.

Table 4.2 Components analysed in the case studies.

Component	Aspects (measurement issues)
General features	Location Ecosystem type Ecosystem service description and category Management option Scale of the ES Environmental threat Target population Number of beneficiaries
Context	Availability of natural resources Road access Proximity to urban centre Labour availability Natural resources' state and access
ES Impact Indicators	Carbon stock changes (CERs or ha) Water quantity (m ³ or protected ha), Biodiversity (protected ha) Non-wood forest products (ton or ha) Ecotourism (protected ha) Cultural service (conserved species or ha, resulting from a specific cultural service)
Socioeconomic Impact Indicators	Perceived income impact (maintained, reduced or increased) Benefit distribution: Price of ecosystem products to the producer and the consumer Number of links in the commercialization of products Level of transformation of the product Role of the target population in the scheme Type of benefits received by the target population Type of resources provided by the target population Potential of the scheme for financial transfer from rich to poor sectors
Replicability evidence	Evidences of replications Participation of donors in the experience (% of total costs, kind of contribution) Type of donor Participation of investors, governments, NGOs (% of total costs, kind of contribution)
Sustainability	Resource use management plan Type and role of partners or associated stakeholders Type of alliance (public, private or public-private) Type of matching funds Dependence on external contribution

Table 4.3 introduces the 12 projects reviewed in this situation analysis in terms of MO type, name, and location. A more detailed description can be found in Annex 9.

Table 4.3 Location, description, and initial situation of reviewed case studies

Management option	Name of experience	Location
(1) Fair trade certification and organic certification	Organic coffee certification and fair trade. CECOVASA (Farmers cooperative)	Puno Province, Peru
(2) Ecotourism	La Chonta ecotourism project	Department of Santa Cruz, Bolivia
(3) Ecotourism	Chalalán : A community-based ecotourism project	Bolivia, Madidi National Park (between 6000 and 200 masl)
(4) Conservation of goods and cultural services provided by ecosystems	The Potato Park: Agro-ecotourism, conservation of native potato varieties and of indigenous peoples' traditional knowledge	Pisac, Cusco. Sacred Valley of the Incas (3600-4600 masl), Peru.
(5) Commercialization of non-traditional products to reduce pressure on forests	Coconut fibre for manufacturing automobile parts and conserve the rainforest	Marajó Island, Pará state, Northern Brazil.
(6) Extractive reserve and certification of sustainable forest management	Chico Mendes: An agro-extractivist reserve with forest management certification	Municipality of Xapuri, Acre, Brazil.
(7) Extractive settlement and certification of sustainable forest management	Seringal Porto Dias, Extractive Settlement Project with forest management certification	Municipality of Acrelândia, Acre, Brazil.
(8) Carbon credits generated from reforestation	Plantar Reforestation Project	Minas Gerais, Brazil (Cerrado)
(9) Carbon credits generated from carbon sequestration	Peugeot / ONF Project: Reforestation project for carbon sequestration	Municipalities of Juruena and Cotriguaçu, Northwest Mato Grosso state, Brazil
(10) Carbon credits generated from reforestation and avoided deforestation	Noel Kempff National Park: A CO ₂ emissions avoidance (avoided deforestation) project	Chiquitania, Department of Santa Cruz, Northeastern Bolivia.
(11) Carbon credits generated from reforestation and avoided deforestation	Bananal Island Carbon Sequestration Project for social equity	Bananal Island, Tocantins state, Brazil.
(12) Payment for hydrological services: conservation of forests	Payment for Environmental Services for the conservation of the cloud forest	Bolivia, Los Negros River watershed, Department of Santa Cruz.

4.2. Criteria used to assess the impact on ecosystem services and well-being of case studies' management options

Six criteria were used to assess impact: 1. time frame for capturing economic benefits, 2. reversal of environmental degradation/conservation of ES, 3. local added value, 4. redistribution of benefits, 5. community empowerment, and 6. potential for transfer of resources from wealthier to poorer sectors. These criteria and relevant assumptions are presented in Table 4.4.

Table 4.4 Criteria for evaluating case study impacts on ecosystem services and well-being

Criteria	Assumption	Qualification
Time frame for capturing economic benefits	Long-term benefits do not solve immediate needs of the poor (high discount rates that apply to poor communities reduce magnitude of long-term benefits)	Short-term benefits: + Long-term benefits: -
Reversal of environmental degradation / conservation of ES	Reduction of degradation processes or conservation of ES prevent poverty and contribute to improve well-being conditions.	Diminish degradation/improves conservation: + Does not contribute to stop degradation or to conservation: -
Local added value	Local incorporation of added value to ecosystem goods permits to increase the economic benefits for the local communities.	Does exist: + Does not exist: -
Redistribution of benefits	Direct involvement of communities in the distribution of benefits avoids concentration of benefits by wealthier sectors and maximizes community economic benefits.	Producers are land owners: + Producers capture higher benefits than consumers: + Small producers capture higher benefits than medium and large-scale producers: +
Empowerment of communities	When local communities are partners (not only beneficiaries), the project will have a higher probability of increasing well-being.	Locals directly promote new alternatives: + Locals are involved in commercialization alternatives: + Locals are part of management decision-making and implementation: +
Potential for transfer of resources from wealthier to poorer sectors	Transfer of resources from wealthier to poorer sectors results in a higher probability to increase economic benefits and equity.	The management option gives opportunity to such transfer :+ The management option does not give opportunity to such transfer : -

Results are synthesized in Table 4.5. Below we summarize the key results of the case study analysis for each of the six criteria and additional, albeit not systematically measured, performance indicators.

Criterion 1. Economic benefits and the required elapsed time to capture them

Commercialization of goods in established markets provides immediate economic benefits to communities. Examples of such markets include those of certified products with ES benefits such as organic coffee (e.g. shade grown and fair traded brands) and a few non-timber forest products. Hence, they also address Criterion 2. ES are maintained via price mechanisms directed largely towards the good rather than the service per se.

Another mechanism that could provide immediate economic benefits in the short-term is PES for hydrological services provided through forest protection in upper catchment areas of the Andes.

However, payments often barely cover the opportunity cost of forest protection and, hence, bring about few welfare gains. One of the cases in Bolivia (see Annex 9) featured in kind payments to promote honey production which has a potential to provide higher cash flows and profitability than traditional slash-and-burn agriculture.

In some cases, practical applications of MO only resulted in long-term or small welfare gains, for example, in carbon sequestration and reforestation projects or ecotourism, where the community may participate only earning day wages equal to gains from agricultural or other traditional activities.

Table 4.5 Evaluation of socioeconomic and environmental criteria of management options explored by the case studies.

Management option	Criteria					
	1	2	3	4	5	6
	Economic benefits (income / productivity)	Reversal of environmental degradation / ES conservation	Local added value	Redistribution of benefits	Empowerment of communities	Potential of resources transfer from wealthier to poorer sectors
Extractive reserves						
Forest management certification						
Fair Trade / organic certification						
Commercialization of non-traditional products						
Ecotourism						
Carbon stock increases through reforestation / afforestation projects						
Carbon stock increases through avoided deforestation						
Protection of ecosystems' cultural services						
PES (hydrological services)						

Criterion 2. Reversal of environmental degradation and/or ES conservation

Few projects directly measured the impacts of management options on specific ES. We therefore use proxies such as the number of hectares conserved or the amount of carbon not emitted or removed from the atmosphere. However, considering these proxy variables it was found that all management options are directly or indirectly contributing to ES conservation or enhancement.

Criterion 3. Local added value

Certified shade grown coffee and transformation of non-timber forest products, or non-traditional agricultural products (e.g., coconut fibre for the car industry) are good examples of the local value added criterion if demand remains stable. This criterion does not pretend to disqualify other experiences that by nature could not imply an added value locally (such as protected areas), but it places a premium for experiences that have and take advantage of this opportunity.

Criterion 4. Redistribution of benefits

It appears that several MO have resulted in benefits for poor stakeholders whenever:

- Land and/or resource tenure is secure.
- Beneficiaries directly participate in commercialization of an ecosystem good.
- PES payments are direct to ES providers.
- Local communities are prioritized as beneficiaries when cultural services or traditional knowledge is applied to natural resource management (NRM) (e.g., Potato Park in Peru).

Few benefits were captured in other cases due to:

- Local populations served as a labour force (e.g., in reforestation/afforestation projects intended to build C stocks) rather than as recipients of social benefits.
- Land managed for avoided deforestation or C emissions was owned by the state.
- Where a large portion of benefits from ecotourism are captured by commercial interests (e.g., the Chalalan Ec lodge in Bolivia).

It is important to note that benefits for the poor often do not depend on the selection of MO, but on project design and implementation.

Criterion 5. Community empowerment

Beyond financial gains, local communities valued improved capacity to manage and obtain new resources, to organize themselves to achieve common objectives, and to perform new activities. Most projects contributing positively in this regard did so because:

- Extractive reserves, by definition, require involvement of local communities in sustainable management and, sometimes, in commercialization of forest products.
- Ecological certification also often includes requirements for working conditions (e.g., as in the reviewed case of certified timber extraction).
- Fair trade certification has required farmers to be organized in cooperatives, which in turn, promotes social capital. Certification also requires clarification of land tenure rights, which can help to empower communities.
- Community based collection, transformation, and commercialization of non-forest products

requires organization and administrative capacities. The reviewed projects have facilitated such capacity building.

- Recognition of cultural values, traditional laws and knowledge, and local institutions can lead to empowerment, as in the Potato Park case.
- PES schemes that replace ES degrading activities by others, have provided training and generated new skills--as was the case in Bolivia, where forest conservation and honey production replaced slash-and-burn agriculture.

Community empowerment was weak or zero if communities merely served as labour force instead of being involved in a participatory manner throughout project planning and execution (e.g., in foreign investment projects to build carbon stocks). On the contrary, whenever social benefits from reforestation were an explicit project goal, communities were empowered through involvement (e.g., the contrast between the Bananal Island Project and the Plantar Project). To promote community empowerment in avoided deforestation projects, such projects must provide locals with alternatives instead of merely compensating them financially for their opportunity costs.

Criterion 6. Resource transfers from wealthier to poorer social sectors

The type of markets evolving around goods and services with ecosystem components influences the extent to which resources can be redistributed among stakeholders. Rubber and conventional timber are usually traded in competitive markets that provide little niche opportunities for smallholders. Scarce or somehow exclusive goods, however, may allow smallholders to capture price premiums - as is the case of certified organic coffee and other fair trade products, and Brazil-nuts. As mentioned in the previous chapter, ecotourism also provides opportunities for resource's transfer from wealthier to poorer sectors. So do PES schemes that bundle carbon services with cultural services, such as landscape beauty and recreation. In these cases, demand generally comes from visitors and buyers from developed countries (see previous chapter for caveats).

Resource transfer was less evident in the avoided deforestation projects and hydrological PES schemes analysed. In the avoided deforestation project in Bolivia, for example, carbon credit revenues are not received by poor local communities because the state owns the project.

Service buyers in the Negros PES scheme, Bolivia, are small, low-income downstream municipalities. They pay upstream farmers, but the amount barely covers the low opportunity cost of maintaining undisturbed the cloud forests, compromising efficiency in achieving ES objectives. This is a strong argument for not implementing PES schemes where the willingness (or capacity) to pay is lower than the costs of maintaining ES flows. Where such conditions prevail, PES will not work.

Cultural services linked to the management of ecosystems in the Andes showed little resource transfer potential. Although native potato varieties are being protected in the case of the Potato Park, there is little evidence of willingness to pay for the good, in part because the varieties are already domesticated and commercialized. There also appears to be little demand for the traditional knowledge promoted by the potato park.

4.3. Replicability and cost-effectiveness of case studies

4.3.1. Replicability of cases

Most of the reviewed projects show potential for replication only under specific conditions and

subject to adaptations. Assessing replicability requires analysing project failure and success and potential for scaling up. Most reviewed projects started between four and 20 years ago - time enough to demonstrate potential for scaling up. Some considerations regarding replicability of the reviewed projects include:

- Fair Trade projects. Several other projects that were not reviewed rely on fair trade to deliver both socioeconomic and environmental benefits.
- Community-private enterprise partnership for commercialization of non-traditional products: The initiative of Pará, Brazil, producing coconut fibre by-products was motivated by a similar South African project and, subsequently gave rise to a project in Belém, Brazil, using curauá palm fibre for a paper factory.
- Extractive reserves and certificated community based-forest management: The concept of extractive reserve resulted from the pioneer work of Chico Mendes and rubber tappers from the Brazilian state of Acre, and has expanded from the four reserves created in 1990, to 39 extractive reserves (35 of which in the legal Brazilian Amazon) that occupied almost 10 million hectares by the end of 2006.
- Community based forest management projects tend to be associated with the process of certification. In Bolivia, there are 2,157,694 ha with sustainable forest management already certificated (CFV 2006). By early 2008, 20 certified management projects totalled more than 1.6 million hectares in natural forest areas of the Brazilian Amazon (FSC 2008).
- Carbon projects: The selling of Certified Emission Reductions (CER) through reforestation/afforestation activities has been replicated. In some cases CER are seen as a way to recover a part of upfront reforestation costs and locals are initially employed, but capture few benefits. In others, private companies attempt to demonstrate corporate social responsibility by delivering social and economic benefits to locals as enterprise partners.
- Ecotourism and PES: These efforts are being replicated in general rather than in reference to the reviewed projects. For example, the idea of in-kind PES and the investment of US \$1.4 million in Chalalan, Bolivia, to create an ecotourism lodge managed by locals have yet to show replication potential.

The conclusions regarding replication are:

Private coffee projects that included profit-motivated training contributions resulted in higher prices paid for certified and/or transformed ES and goods. In the coffee and forest certification processes, not only a better price but the clarification of land tenure enabled the scaling out of that management option.

Carbon project management options are replicable; albeit benefits to local populations are tied to other factors.

For extractive reserves, replicability has much to do with compliance with policies regarding land tenure and value chain development for extractive products resulting reductions in social and political conflicts. Also, the extractive reserves must have a state level framework to be officially recognized, and there should be an organized, pro-active stakeholder group (such as the rubber tappers in Brazil) interested in and pushing for the policy instrument.

In some projects, development and conservation agencies funded or subsidized testing of MO. In the absence of such investments replicability could not be determined. Again, the highly funded ecotourism project and PES projects where payment sources come from foreign conservation organizations come to mind. Yet, these costs are not included routinely nor analyzed transparently

in the accounting for the effectiveness of such initiatives. Moreover, high funding is not replicable by definition, and tends to undermine community organization, in addition to creating dependency and vulnerability to inspection and control.

4.3.2. Cost effectiveness of achieving environmental management objectives

Effectiveness of MO should be assessed by comparing costs of the measures relative to ES outcomes, and the enhancement of well-being (Chapter 3). Unfortunately, the case studies often provided little information regarding costs and well-being indicators of outcomes.

Where information was reported, cost-effectiveness for environmental objectives was assessed using number of ha managed or conserved as a proxy variable. For example, in projects related to water quantity and biodiversity, conserved forested area is used as an indicator. Regarding carbon stocks and avoided deforestation projects, amounts of expected carbon removals or avoided emissions are calculated; although the magnitude of investments are not reported.

For income generation, salaries or total income were used as indicators of well-being. The cost effectiveness of improving well-being is not addressed in this section but it is reflected in the qualitative analysis conducted of the six previously explained criteria.

In terms of environmental cost effectiveness, large projects included the Noel Kempff carbon trading project via avoided deforestation, the Chalalan ecotourism project, and the coconut fibre project. Investments were from US\$ 4.60 to 23.00 per ha. The largest project was Noel Kempff with 890,000 ha and an investment of US\$ 11/ha, while the ecotourism project (300,000 ha) had an investment of US\$ 4.60/ha. Differences reflect the number of families involved and types of expenditures. The highest investment of these large-scale projects was by the coconut fibre project (US\$ 23/ha) due to infrastructure and training needs for a new and specialized activity.

Areas covered by the reviewed small-scale projects ranged from 250 to 3,000 ha. These focused on ecotourism, PES schemes, and extractive settlements combined with forest management certification. Level of investment varied greatly. The PES scheme in the Bolivian Andes had the lowest per ha costs: roughly US\$ 6.50/ha to protect approximately 3,000 ha of cloud forest. La Chonta (Bolivia) ecotourism project invested US\$ 20/ha, four times more than the investment required for the Chalalan ecotourism project. The extractive settlement project had the highest investment (US \$154/ha) which seems to be due to certification compliance requirements.

It is difficult to identify one option as the most cost-effective. However, some general guidelines could be derived for achieving environmental cost- effectiveness. These guidelines are derived for the management options associated to the projects commented above (Table 4.6).

4.3.3. Cost-effectiveness of management options to generate income

In terms of well-being and relative to number of families and generated family income, fair trade coffee provided the highest benefits (4,316 families with an annual income of US\$ 2,000/family). The coconut fibre project benefited 100 families at US\$ 4,000/year. Unfortunately, the project failed as expected demand did not materialize. The Chalalan ecotourism project benefited 90 families with incomes of US \$706/year/family. The other projects involved either few families or low incomes--as is the case with other ecotourism projects and water-based PES projects. Investment per family in the reviewed projects was estimated between US \$12,500 to US \$54,000. The table below presents factors influencing environmental cost-effectiveness of ES-oriented projects

Table 4.6 Factors influencing environmental cost-effectiveness of ES-oriented projects

Management option	Opportunity	Condition	Threat	Best condition for achieving environmental cost-effectiveness	Potential for poverty alleviation
Ecotourism	Some areas in the Amazon and Andes-Amazon zone with low population could be attractive for tourists, at low investment per ha and per family	Need to control these large areas through property rights and/or declarations as protected areas or national parks	Ecotourism is a market that could be easily saturated	A National Park or declared protected area Attractive and accessible for tourists Low population	Low: Few families are generally involved, and not applicable for a wide range of conditions
Carbon markets: Avoided deforestation	Large forested areas under deforestation pressure, especially in the Amazon	Needed is clarification of land rights to recognize carbon credit beneficiaries	Avoidance of leakages could be something unmanageable or very expensive Illegal land-grabbers & speculators could continue displacing poor communities and get benefits from ES	Land with property rights Large areas still with forest but threatened Low population per ha to avoid high leakage control costs	Medium: While poor communities could lack land tenure rights, the project could be a means to obtain them. Poor communities have lower opportunity costs than big farmers, ranchers, timber companies, making carbon credit prices attractive.
Commercialization of forest products	Those with large areas (extractive reserves) but practicing slash-and-burn agriculture could change to intensive productive systems, reducing the pressure on forest	A productive alternative based on demand. Farmers with large areas suitable for conservation that compensate for high cost of new technologies and alternatives in intervened areas.	Saturation of markets and lack of demand	A productive alternative with market Farmers with access to large areas Land tenure rights	Medium to high: Employment generation depending on alternative; products with stable demand could derive income levels maintained over time
PES schemes – hydrological services	Undisturbed forests playing a role in regulation of water flows but threatened by deforestation pressures. Low opportunity costs for conserving forests because most feature slash and burn agriculture and subsequent extensive cattle ranching	Areas of conserved forest large enough to influence river flows during critical climatic periods.	Lack of capacity to pay by the ES beneficiaries	Forest land with low potential for intensive and profitable production systems Evidence for reduction of water flows and quality because of deforestation	Low Potential beneficiaries in the Andes may be poor communities, but the amount of current payments help maintain rather than increase incomes. To increase income: payments higher than opportunity costs and wealthier ES beneficiaries able to provide higher and stable payments

4.4. Potential of ES management options to reduce poverty and increase environmental sustainability

After revising these selected cases some thoughts have arisen about the potential of MO to reduce poverty and improve ES. Some of them are derived directly from the results obtained from the case studies' analysis. Some other are exposed here as additional ideas that could be considered as options to boost the management of ES for poverty reduction and prevention.

4.4.1. The reviewed management options do not solve the economic deficiencies of current production alternatives in the Amazon

Current production activities in the Amazon bear little potential to generate surpluses and meet short-term needs of the poor. MO, such as forest management certification, extractive reserves and carbon trade, generate benefits related to land tenure, organizational capacity of communities, and local empowerment. Although these types of benefits are important for communities, most of them will be truly an advantage if more favourable conditions are negotiated to capture economic benefits.

Management options such as forest and coffee certification try to open up new market niches for the respective products, which could result in greater immediate benefits for farmers. However, this strategy is not being applied for other Amazonian products.

Most of the studied projects reflect the environmental goals of project promoters rather than on structural or market strategies in trying to benefit poor communities. MO then failed after initial successes based on high investment levels (e.g., coconut fibre production for automotive industry).

4.4.2. Existing MO do not increase environmental competitiveness of the Amazon

Most of the management options are applicable to a broad range of ecosystems (except for, maybe, the extractive reserves, which depend on specific resources). Forest management certification, fair trade mechanisms, carbon credits trading, and PES are applicable to other locations. In the Amazon, these MO need to be able to compete with other areas. Due to low poverty densities in rural areas, one might argue, the Amazon is at a competitive disadvantage where investments seek welfare gains. The competitive advantage clearly lies in providing global ES at low costs. The multiplier effect of increasing income (in this case while improving ES) is greater in the non-Amazon areas of Colombia, Ecuador, Peru, Brazil, Bolivia, and Venezuela than in the Amazon given higher population densities and because several ES could be maintained while increasing agricultural productivity. Most, not all MO, are more competitive where energy, fertilizers, and transport are more easily available compared to the Amazon.

4.4.3. The link between production of ecosystem goods and their commercialization provide few comparative advantages to the Amazon

Sustainable productive alternatives in the Amazon are also implemented elsewhere using similar management practices, but providing higher productivity levels--e.g., as is the case with rubber, passion fruit, cacao, and peach palm. This comparative disadvantage of the Amazon reduces the potential for sustainable exploitation of ecosystem goods and for benefiting the poor. Few other goods with real market options and with low probability of being massively produced in other

ecosystems have been identified for the Amazon. The (so far) successful case of marketing açai (*Euterpe oleracea*) products in the United States and Japan is perhaps the best known exception.

4.4.4. Success of MO in achieving poverty objectives depends on the context in which they are developed

Benefits of conservation projects depend on number of beneficiaries, project area, and opportunity costs among others. Payments for avoided deforestation could be low for a mature forest at equilibrium. To be profitable, investments to avoid leakages should be low as well. This means that projects select areas where communities have few incentives to intervene in the forest (i.e., areas with low quality of soils, few commercial trees, and poor road access). This reduces chances of implementing avoided deforestation projects in populated areas and in communities that lack alternatives to substitute their current forest-based activities. In other cases, projects may out-compete timber companies previously generating employment. This poses real risks to local communities; and therefore requires higher investments in new productive alternatives. In these cases, the net effect on poverty may be zero as a substitution rather than improvement of income is provided.

4.4.5. Effects of Amazon deforestation on global climate could be the only externality that justifies compensations or payments for conservation

Global environmental services derived from the Amazon related to global climate may be the only externality that can justify high investment in the region. This externality could help mobilize resources from the global community; but would require stronger scientific evidence regarding the relationship between deforestation rates and the magnitude of the impact on climate change. Externalities such as water regulation and biodiversity less clearly affect society, but still might be worth enough to motivate local PES schemes.

4.4.6. The transitional zone between Andes and Amazon and the areas of influence of the largest urban centres in the region are well-positioned to derive benefits from ES provision for the poor

The size of the Andean - Amazon region makes sustainable regional development very difficult. The foothills or transitional zone between the Andes and the Amazon (piedmont or *ceja de selva*) is an ES priority as it provides and receives substantial environmental services downstream and upstream, respectively. Few efforts focus on the area, although the region features more fertile soils, market proximity, and technological options than many others. Sustainable and productive alternatives could provide economic benefits to farmers, ES to downstream beneficiaries, and could absorb the labour force of migratory populations. Such development would stem further movement to the lower Amazon such that compensation for environmental services could be negotiated. Surpluses generated could be transferred back to the Andes to compensate for ES that benefit the transitional zone such as the regulation of river flows. Thus the production of economic benefits could match the environmental ones, optimizing land use benefits and making profitable alternatives for providing ES. Other well-positioned zones are the areas of influence of the larger urban centres in the region. The cities of Manaus, Belém and Santarém in Brazil, Iquitos and Pucallpa in Peru, or Santa Cruz in Bolivia, with their increasing problems associated to the impact of unbalanced urbanization in ES, would greatly benefit from concentrated efforts to enhance the provision of services that benefit the urban and peri-urban poor.

Key research issues and questions to be addressed by ESPA: Lessons learned from case studies

1. Improve impact monitoring (ES and poverty indicators, such as those used in this and the previous chapter) in projects and programmes that address poverty and environment linkages
2. Build on the lessons learned set out in this chapter to derive critical conditions for the success and failure of interventions. Ecotourism and certification are promising options, where are they feasible and where not?
3. Develop new indicators that capture ecosystem services provision at temporal and spatial scales relevant for management, which may differ depending on management contexts and objectives.
4. Developing methodologies to estimate (both ex-ante and ex-post) total implementation costs, which may require cost monitoring frameworks especially in the case of large-scale government programs
5. Define criteria for replicability in differing socio-cultural and political contexts.

5. Ecosystem services research, training, and policy needs in the Andes-Amazon region

The situation analysis assessed research, training and policy needs in Brazil, Bolivia, Colombia, Ecuador, Peru and Venezuela. Consultation meetings were convened in each country with relevant stakeholders (November-December 2007); and inter-institutional committees were established. In September 2007, the ESPA-AA team has created a web-site, for the posting of project documents and relevant information related to the situation analysis: www.ecosystemsandpoverty.org. The web-site received more than 4,000 visits during the September-April period. Surveys posted on the internet and handled to workshop participants were used to determine perceptions of stakeholders regarding relationships between ecosystem services and poverty alleviation. Secondary information was reviewed in books, journals, policy papers, and web pages.

Preliminary results were presented to stakeholders from the six countries during two regional workshops (for the Andes and for the Amazon) (January-February 2008). Workshop reports and report of consultations in the six countries can be assessed at <http://www.ecosystemsandpoverty.org/index.php/latest-results/>. Feedback provided by stakeholders allowed for adjustments throughout the project. This chapter includes: (5.1) results of the electronic and personal surveys, (5.2) ecosystem services and well-being research needs, (5.3) training needs, and (5.4) analysis and comparison of policies in the Andes-Amazon region dealing with ecosystem services and their relationship to well-being.

5.1. Stakeholder survey

The electronic survey (administered through: www.ecosystemsandpoverty.org) sought information on four topics: a) conceptual approaches regarding relationships between selected ES and well-being, b) best management options for ES in the region, c) research and training needs and the most suitable institutions and stakeholders in the region, and d) policies that support poverty alleviation through ES management. Of the responses, half came from Brazil and half came from Peru, Colombia, and Ecuador.

Questions that involved the prioritization of ES and their contribution to the welfare of local communities did not reveal clear preferences (Table 5.1). A larger sample would be necessary to distinguish between stakeholder groups and their contexts, which quite likely would have resulted in a more conclusive picture. Stakeholders specially emphasized the importance of hydrological services as well as soil quality and services related to genetic diversity. It became clear that ES with local benefits (e.g. forest products and water quality) bear most potential to improve well-being through direct uses. Nevertheless, stakeholders also recognized the potential to improve local well-being through mechanisms that internalize the global value of ES, such as carbon retention and fixation or biodiversity existence values.

The survey exercise clearly showed that the ES categories used by the MEA may appear intuitive for descriptive purposes, but do rather not come in handy as a conceptual basis for empirical studies. ES need to be much better defined to avoid double counting of service contribution (e.g., interdependencies between genetic diversity and forest products and pest control), clear distinctions need to be made between internal (local) and external (global) benefits when discussing ES benefits with stakeholders. Moreover, ES assessments need to be context specific, as they are valued differently depending on livelihood strategies.

Table 5.1 Stakeholder perceptions ES and their contribution to well-being at local and global scale

ES category	Local well-being contribution*	Global well-being contribution*
Water regulation (quantity and quality)	2	1
Forest products	1	5
Genetic diversity	3	4
Local and regional weather regulation	5	3
Carbon fixation and storage	8	2
Soil quality	4	8
Scenic beauty	9	6
Cultural services	7	9
Pollination	6	11
Disasters' prevention	10	7
Pest control	11	10

*1 highest, 11 lowest priority

Somewhat similar conclusions can be drawn from our attempt to elicit opinions about the usefulness of a variety of poverty measures in the Andes/Amazon context. Stakeholders revealed a preference for nutrition and health related indicators and judged standard poverty measures, such as the poverty-line approach or the dollar-a-day measure least useful. It might well be that this (over-) emphasis on nutrition and health is due to the fact that these dimensions are generally omitted from standard measures; hence, the general approval of the human development index as an integrated poverty measure, albeit without environmental dimensions.

Stakeholders showed a clear preference for payment-based approaches to ES management, such as PES, as promising MO for the Andes/Amazon (Table 5.2). At the same time they emphasized community based management solutions and approved the conventional approach of establishing protected areas.

Table 5.2 Stakeholder perceptions: Promising MO to address ES problems in the Andes/Amazon

MO type	Local well-being contribution*
Payments for ecosystem services	1
Traditional and community management	2
Protected areas	3
Sustainable productive systems	4
Environmental education	5
Improving governance	6
Forest (use) management	7
Ecotourism	8
Territorial planning	9

*1 highest, 9 lowest priority

As main barriers to the introduction of more innovative MO, stakeholders mentioned policy and methodological barriers as well as training needs. Cultural barriers were judged of rather minor importance.

In general, the electronic survey results are not inconsistent with findings in Chapters 2, 3 and 4. They confirm the importance of locally valued and poverty relevant ES, such as water quality and biodiversity related services (e.g. forest products). These are, in fact, the ES to which traditional livelihood strategies are most adapted and that, therefore, represent a priority for interventions that aim at maintaining local well-being through local ES conservation. However, stakeholders do recognize the opportunities that stem from the global ES that the Andes/Amazon ecosystems provide, arguably, at a comparative advantage. Nevertheless, stakeholders are aware of the barriers that need to be overcome to convert these global ES into income for marginalized populations in the region. As the following sections indicate, at least the methodological and capacity related dimensions of these barriers clearly represent entry points for the ESPA programme.

5.2. Ecosystem services and well-being research needs

Both in the electronic survey and in consultation meetings, stakeholders identified key knowledge gaps regarding ES management in the following fields: hydrology, meteorology, and general ecosystem functioning; local perceptions of well-being and ES, and socioeconomic as well as cultural factors affecting ES use and modification. These gaps were similar across countries. A strategy to address research gaps must acknowledge the specific potential and importance of each ES in a country or region. For example, even though water services were identified as key throughout the region, water quantity is the main need in the Andes; while water quality is the priority in the Amazon. Therefore, research in the Andes should focus on understanding the potential of ecosystems to provide and regulate the amount of water; while research in the Amazon needs to examine the role of ecosystems and vegetation cover on water purification. The latter involves research not only on the dynamics of demand and supply of ES, but also on ES independent market forces and failures that affect ES through externalities.

Table 5.3 presents research priorities identified for each ecosystem service or main research subject and potential responses for the ESPA program (see potential institutional partners in Annex 10). For research needs associated with specific ecosystem services, information needs for decision making are emphasized (hydrology, productivity, carbon stocking rates). Monitoring protocols using standardized methodologies are needed for all services considered. Such protocols require cooperation among organizations such as the ones participating in the ESPA Program.

Table 5.3 Information gaps, research needs, and proposed solutions (source: ESPA electronic survey and national and regional consultations).

Ecosystem Service / Research Subject	Research Priorities	ESPA Program Potential Actions
Water services	Basic hydrological information (evaporation, precipitation, flows)	Develop a regional network of experts and institutions to gather basic information through standardized methodologies (to include a regional database)
	Monitoring protocols	
	Relationships among different types of ecosystems and their capacity to store and produce water	Develop a program to assess the capacity of natural and transformed ecosystems to store, regulate and clean water in the Andes - Amazon region.
	Relationships among different types of ecosystems and their capacity to improve water quality	
	Restoration and sustainable management options methodologies	Develop standardized methodologies for management options that contribute to poverty alleviation (PES, community ecosystem management and protected areas)
	Determination of the impact of climate change on water services	Develop a program to assess the effects of climate change on natural and transformed ecosystems and their capacity to store, regulate and purify water in the Andean - Amazon region.
Soil Services	Basic edaphic research on Andean - Amazon region	Develop and consolidate a regional network of experts and institutions that gather basic information through standardized methodologies (include regional data base).
	Monitoring protocols	
	Land use changes and their relation to productivity and water regulation assessment	Develop a program to determine the impact of land use changes on soil productivity and provision of other services in the Andean-Amazon region.
	Soil restoration and management methodologies	Develop standardized methods for management options that contribute to poverty alleviation and were identified for the region (PES, community ecosystems management and protected areas)
	Productive systems optimization protocols	Develop standardized methods that minimize negative impacts and improve provision of ES by production systems.
Climate regulation services	Assessment of C stocking rates of native vegetation	Develop a program to assess the capacity of natural and transformed ecosystems to store and fix carbon in the Andes-Amazon region.
	Amount of carbon stored in vegetation, soil and water.	
	Methane and other carbon equivalent compounds estimations in water bodies.	Develop a program to determine the capacity of Andes-Amazon water bodies to regulate emissions of methane due to organic matter decomposition.
	Development of fair and equitable mechanisms to recognize carbon sequestration.	Develop a program to evaluate the fairness of carbon projects and to formulate strategies to improve the welfare of the vulnerable and poor.

Ecosystem Service / Research Subject	Research Priorities	ESPA Program Potential Actions
	Amazon dieback: developing a framework for assessing likelihood, and potential impacts for local people, biodiversity and global climate.	Taking on the recommendations of the Oxford 2007 Conference through scenarios analyses based on collaboration with LBA project and additional work with local stakeholders to assess the likelihood of the dieback scenarios, the causal processes and the potential implications for the Amazon and beyond.
	Monitoring protocols	Develop and consolidate a regional network of experts and institutions that gather basic information through standardized methodologies.
Ecosystem Products (Goods)	Sustainable use protocols	Consolidate a network of experts and institutions to gather basic information using standardized methodologies.
	Monitoring protocols	Consolidate the biotrade and <i>Bolsa Amazonia</i> programs, focusing on implementation of biotechnology as a key factor to add value to Andean-Amazon products.
	Biotechnology implementation	
	Generation of added value for products obtained from the ecosystems.	Consolidate a network of experts and institutions to advance development of biodiversity inventories in areas of high risk of transformation. (including a regional database)
	Flora and fauna inventories	
Biodiversity services	Traditional uses and techniques assessment	Develop a program to assess cultural knowledge concerning management and conservation of ES in the Andes-Amazon region.
	Restoration methodologies	Implement pilot studies to standardize methodologies of natural restoration to improve the provision of biodiversity services.
	Evaluation of impacts on biodiversity use	Consolidate a network of experts and institutions to gather basic information using standardized methodologies (including a regional database).
Social and Poverty Issues	How ES and well-being are perceived by different types of local communities	Facilitate a program to develop poverty indicators based on local perceptions of well-being and ES.
	Poverty indicators needed to account for Andean-Amazonian conditions	
	Evaluate the vulnerability of communities on ES depletion	Implement pilot studies to determine the contribution of ES to consumption and well-being of local communities in Andean-Amazon region.
	Determine the contribution of ES to self-consumption	
	Collective action, associative arrangements and life plans	Strengthen collective arrangements for natural resource management based on community life plans.
Market Issues	ES valuation	Develop a program to standardize economic valuation of ES in the region.
	Value chains	Consolidate biotrade and <i>Bolsa Amazonia</i>

Ecosystem Service / Research Subject	Research Priorities	ESPA Program Potential Actions
	Added value of ecosystem products	programs, focusing on biotechnology as a key to generate added value to Andean-Amazon products obtained from natural resources.
	Market surveys and tendencies	Identify trends in ES consumption or use to establish the demand tendencies and the potential to generate markets for ES.
	ES market creation	Develop a regional PES program focusing on priority ES (water quantity and quality, soil services and ecosystems products)

Two questions recurred throughout the enquiry. First, the scales at which different ecosystems provide benefits to humans; and, second, how ES provision changes as ecosystems are transformed (see also Chapter 3 for a discussion). Programs need to be able to measure the capacity of Andes/Amazon ecosystems to provide services and to identify intervention mechanisms that favour maintenance or enhanced ES provision.

The survey and national and regional consultations also emphasized the need to: a) consider traditional knowledge of natural resource use (e.g., build an inventory of traditional management practices through participatory mechanisms), and b) examine the influence of market forces on the provision of ecosystem services. The latter involves research not only on the dynamics of demand and supply of ES, but also on ES independent market forces and failures that affect ES through externalities.

5.2.1. Proposed agenda for the ESPA Program to address research needs

Here we consolidate the identified research gaps in five program components, with the objective of advancing the understanding of ways that ES can benefit vulnerable and poor populations in the Andes/Amazon. The components of this agenda are presented next. Chapter 6 proposes key sites and contexts where advances in each component are likely to bear potential to scale up results.

- Identification, characterization, definition, and valuation of ES provided by natural and transformed ecosystems in the Andes/Amazon.
- Especially for difficult to value ES, assessment of the multiple contributions of ES to well-being of vulnerable and poor populations in the Andes-Amazon region.
- Development and/or adaptation of MO and intervention strategies in natural and transformed ecosystems. Focus on maintaining and enhancing ES benefits for vulnerable and poor populations and integration with national/regional economic development objectives and related tradeoffs and synergies.
- Development and support of pilot studies that establish the key relationships between ES and well-being.
- Mechanisms to strengthen institutions related to ES and poverty alleviation in the Andes/Amazon

5.3. Ecosystem services and well-being training needs

Training and capacity building needs to focus on strengthening primarily local government

structures and the institutional environment (NGOs, civil society organizations and the local and regional education sectors) involved in making MO work. Stakeholders identified key issues during the national and regional workshops. In order of importance, these are:

- Building awareness of ES – well-being interrelationships and the role of humans in modifying them.
- Mainstreaming the inclusion of traditional knowledge in the development of new technologies for resource use and transformation.
- Disseminating skills and methods for monitoring and documenting ES – well-being relationships (e.g. use of open source software and data base management, training in valuation methods).
- Mainstreaming ES – well-being relationships in ecological and economic zoning approaches.
- Improving environmental fundraising capacity of local institutions (focus on new opportunities at national and international level, such as PES).
- Disseminating best-practices in ES management (promoting exchange and dialogue among stakeholders in similar contexts).

In addition, stakeholders identified information needs for each selected ecosystem service. For hydrologic services, programs to increase capacity of stakeholders in integrated watershed management and to identify and assess the impacts of climate change are needed. Information needs regarding soil quality are related to methods of assessment, measurement, and soil quality management approaches. For climate change mitigation, capacity building of local stakeholders to participate in carbon markets and other modalities are required. Finally, strengthened capacity of local stakeholders to participate in markets of forest products, negotiate resource access, and protection of traditional knowledge are needed.

Stakeholders emphasized the need for training programs tailored to regional priorities that integrate ecosystem services with improvement of local well-being (Annex 11 shows training organisations). It was recognized that existing programs and initiatives rarely provide an integrated view of environmental and economic issues, provide little follow up and dissemination and are deficient of trained personnel, funding and infrastructure.

A key limitation was lack of funds. It was deemed urgent to further involve the following donor and cooperation agencies: multilateral (IDB, World Bank, UNESCO, UNDP, GEF, FAO); bilateral (European Union, DFID, GTZ, USAID, AECI); regional organizations (ACTO, Andean Community of Nations, IICA); private sector (oil companies); private foundations (e.g., the BBVA, Moore, Ford, MacArthur, and Gates foundations); global NGOs (WWF--Russell Train Scholarship, IUCN, CI, TNC), national, regional and local governments, and universities and research centres based in the region and abroad. These organisations are currently involved in different programmes with training and capacity building components that could represent entry points for an ESPA capacity building strategy.

During the national and regional workshops, participants identified a number of activities that can be carried out to develop the proposed training and capacity building agenda (Table 5.4) and the key institutions that are potential sources of support for such activities (see also Annex 11).

Table 5.4 Activities and institutions identified as having potential to increase the capacity of local and regional stakeholders.

Activity	Key institutions considered by stakeholders
<ul style="list-style-type: none"> ▪ Stakeholder consultations ▪ Promoting networks among existing training and capacity building programs and projects ▪ Extract lessons learned from these programs ▪ Building networks among organizations that execute training and capacity-building ▪ Multi-disciplinary definition of specific training and capacity-building needs ▪ Basic education and media involvement 	<p>Regional Level:</p> <ul style="list-style-type: none"> ▪ National or regional NGOs in collaboration with local governments, with support from international NGOs ▪ Research organizations, consortia and programs ▪ Regional government level organizations <p>National Level:</p> <ul style="list-style-type: none"> ▪ National NGOs in collaboration with local governments, with support from international NGOs ▪ Governments ▪ Universities

Based on the above, the following actions are considered as priorities for the ESPA Program:

- Help identify the information needs and support involvement of different stakeholders in training and capacity building programs related to ES and well-being.
- Establish mechanisms to link to existing national and international programs, e.g. in technical cooperation agencies, universities, research centres, NGOs, etc., in order to include ES and well-being issues in research, training and capacity building programs in the region.
- Implement training and build capacity in the area of ES and well-being.
- Develop ways to share experiences and lessons learned, reduce weaknesses, and maximize strengths of existing programs across national boundaries.
- Increase awareness among local stakeholders (governments, communities, etc.) of the relevance of implementing training and capacity building programs in the area of ES and well-being.
- Increase awareness of governments regarding the importance of these programs in the making of social, educational, and environmental policies

5.4. Policies dealing with Ecosystem Services and their relationships to well-being

Major drivers affecting the Andean-Amazonian environments result in deforestation and, hence, carbon emissions and biodiversity loss. On the other hand, growing international demand for non timber forest products and for ecosystem services such as carbon and hydrological services offers new opportunities for both environmental sustainability and improvement of the well-being of local populations. Several governments have therefore developed policies to reduce deforestation.

Environmental strategies and action plans seeking sustainable development have been developed at the national level within the Andes-Amazon region. All the Andean-Amazonian countries have ratified multilateral environmental agreements acknowledging and promoting the conservation of

ecosystem services. The Convention on Biological Diversity (CBD) includes an ecosystem-based approach in its policy and legal framework. The approach stresses the need to protect ecosystem services, establish protected areas, and design incentives that protect provision of these services. The United Nations Framework Convention on Climatic Change (UNFCCC) and the Kyoto Protocol acknowledge the importance of forests for climate change mitigation. The United Nations Convention to Combat Desertification (UNCCD) stresses soil protecting forest services. The RAMSAR Convention on Wetlands assessed the role of wetlands in the regulation of water services, and builds on the recommendations of the MEA (Resolution IX.1). RAMSAR encourages signatory countries to designate areas for inclusion in a list of globally relevant wetlands.

Based on secondary sources, we reviewed the approaches taken by Andes/Amazon countries to implement these environmental agreements. We also evaluated policies and legal instruments in terms of how they seek fair distribution of the benefits and the mechanisms proposed for attaining their objectives. Information is provided in Annex 12 on legislation and respective relationships with the ecosystem services.

5.4.1. Results

Delegates to the Climate Convention meetings in Bali recognized the “urgent need” to reduce emissions from deforestation. They launched the adaptation fund, a “mechanism that shall finance concrete adaptation projects and programmes that are country driven and are based on the needs, views and priorities of eligible parties”. This mechanism provides substantial opportunities.

At regional level, the Regional Strategy for Biodiversity of the Andean Community of Nations (CAN) acknowledges the role of traditional communities in maintaining biodiversity. The Amazon Cooperation Treaty Organization (ACTO) seeks to unite the efforts of its member countries in promoting development of the Amazonian region in a way that guarantees an equal distribution of the benefits derived from the sustainable use of the natural resources and the improvement in the well-being of its inhabitants.

Regarding forest products, the Bolsa Amazonia program (created in 1998 by the BIOTRADE initiative of the United Nations Conference on Trade and Development--UNCTAD) promotes value chain initiatives that contribute to the sustainable use of the biodiversity of the Amazonian region. In 2002, CAN in collaboration with the Andean Development Corporation (CAF) and UNCTAD developed the Andean Program of Biotrade. Colombia pioneered a National Program for Sustainable Biotrade that promotes collection, production, processing, and commerce of goods and services derived from native biodiversity, under parameters of environmental, social, and economic sustainability. Peru, Bolivia, Ecuador and Venezuela have implemented similar programs with the support of UNCTAD.

Progress is being made regarding the design and establishment of policies for compensating and paying for environmental services. The Public Policy for the Acknowledgment of Forest Ecosystem Services of the Department of Santa Cruz, Bolivia (established in 2007) attempts to financially compensate owners of forest areas who provide such services. In 2003, Brazil's federal government created the Socio-Environmental Development Program for Smallholder Production, (PROAMBIENTE) which considers the concept of bundling of environmental services provided by smallholders. PROAMBIENTE evolved from social movements that sought to reconcile productive and conservation activities. Now managed by the Department of Policies for Sustainable Development of the Brazilian Ministry of the Environment, the program provides financial incentives for investing in sustainable production systems that also provide ecosystem services. To be eligible for incentives, producers must conserve biodiversity, soils, and water resources; and must reduce

deforestation and the use of fire. Since 2007, Colombia is developing a National Strategy for Payment of Ecosystems Services.

The Program for Protected Areas of the Amazon Region (ARPA) was created in 2003 by the Federal Government of Brazil and coordinated by the Ministry of the Environment. The program has created 41 protected areas covering 22.5 million hectares. ARPA represents a new conservation approach relying on new legal, institutional, and economic mechanisms for the financial sustainability of the system.

These initiatives highlight the need to protect ecosystems and their services, at different scales through different mechanisms. In the next section, we present conclusions regarding policies on biodiversity and protected areas, forests and water resources. Discussed are ecosystem services covered by the policy; the connection between these services and well-being, and the policy mechanisms that try to secure the provision of services (see table in Annex 12). We attempt to show progress being made without drafting an exhaustive list for all countries.

5.4.2. Policies on biodiversity and protected areas, forests and water resources

5.4.2.1. Biodiversity and protected area policies

All countries in the Andes/Amazon recognize that protected areas secure the provision of services for economic, social, and environmental development. The Protected Areas Policy of Colombia assesses the role these areas play in the provision of services such as genetic resources, climate control, maintenance of flora and fauna, maintenance of watershed functions, and cultural services such as recreation, education, and scientific opportunities. Policies also acknowledge services by type of protected area: National Recreation Areas in Ecuador are connected to services of scenic beauty. Peruvian Historical Sanctuaries were established to protect cultural services.

Policies have gradually recognized areas populated by indigenous and peasant communities. In Brazil, the 2006 National Strategic Plan for Protected Areas highlights the importance of indigenous lands. The National Parks' Policy of Colombia recognizes the autonomy of indigenous communities. The National Strategy on Biodiversity maintains that communities must have access to land with consolidated rights to guarantee that benefits derived from biodiversity are fairly distributed. Ecuador's National Biodiversity Policy and Strategy (2001-2010) emphasizes the participation of indigenous and Afro-Ecuadorian peoples as well as local communities in the decentralized management of protected areas and ecosystem services

Brazil has noteworthy experiences growing from the enacting of the policies for protected areas, like the extractive reserves created in the Amazonian region. These areas have counteracted the negative effects of policies that fostered conversion of forests into grazing and croplands. The National Environmental Law of 1998 in Brazil grants concessions for sustainable community use and conservation of renewable natural resources. Through the Chico Mendes Bill of 1999, rubber tappers in the state of Acre began to be compensated for their contribution to maintaining the forest by a 20% subsidy added to the price of natural rubber.

Most countries have made progress in their policy instruments and mechanisms. Ecuadorian legislation has developed mechanisms that aid populations dependent on marginal production systems. Brazilian biodiversity legislation (since 2002) compensates for services provided in protected areas by instruments such as the ICMS Ecológico (Ecological Tax on the Circulation of Goods and Services), a fiscal incentive for biodiversity conservation that compensates municipal governments for the loss of potential tax revenue resulting from the creation of protected areas.

5.4.2.2. Forest Policies

Some national policies acknowledge the importance of forests in the provision of ecosystem services and offer key definitions on the subject. In Ecuador, ecosystem services are defined as, “benefits that the humans directly or indirectly gather from the functions of biodiversity (ecosystems, species and genes), specially ecosystems and native forests and forest plantations...” In the Forest and Wildlife Law of Peru (since 2001), forest ecosystem services are defined as those, “...whose purpose is to protect the soil, water regulation, conservation of biological diversity, conservation of ecosystems and scenic beauty, carbon dioxide absorption and generally the maintenance of essential ecological processes.”

Regarding ecosystem services and well-being, forests, if used sustainably, are acknowledged as prime providers of goods and services. Bolivian forest policy, supported by the Sustainable Forest Management (BOLFOR) project, declared that areas providing Brazil-nuts, gums, and palm hearts, among others, will be preferably granted to traditional users such as peasant associations.

Policies also address territorial zoning, forest management plans, voluntary forest certification, and incentives. In Colombia, state granted economic incentives through the Certificate of Forest Incentive for Reforestation (CIF) reward reforestation by private concessionaires and the positive social and environmental externalities derived. Commercial forestry is not allowed in the Venezuelan state of Amazonas. In Bolivia, market instruments such as forest certification included in the Forest Law of 1996 are being implemented. As a result, more than 2.5 million hectares have been certified, contributing to sustainable forest management.

National policies on climate change have responded to the Convention on Climate Change and the Kyoto Protocol. Colombia in 2002 identified strategies to face climate change, mostly regarding sale of mitigation services, and is currently developing the National Policy on Climate Change. In recent years, the Brazilian government has implemented several measures to reduce deforestation, including the expansion of protected areas, stronger enforcement to control illegal logging, and the introduction of better certification of land ownership. At the Bali 2007 meetings of the UNFCCC, Brazil presented a detailed plan to promote reduced emissions from deforestation (REDD), renewable energy, and clean development mechanisms.

Indigenous lands are undoubtedly an effective management option in terms of slowing down forest clearing and conserving biodiversity in high-deforestation frontier regions. This is the case for Indigenous Communal Land Holding (Tierra Comunitaria de Origen, TCO) in Bolivia, and Native Community Territories (Comunidades Nativas) in Peru. Indigenous lands occupy 20% of the Brazilian Amazon, and are considered the most successful barrier to deforestation. As opposed to parks and other inhabited protected areas, indigenous lands provide livelihood security to communities that would otherwise be extremely vulnerable in their pursuit for social reproduction. Despite increasing contact with the larger society, the example of indigenous lands in the Brazilian Amazon, which present significantly low deforestation rates when compared to areas under protection in parks, attests the effectiveness of the approach in both promoting ecosystem services and enhancing livelihoods.

5.4.2.3. Water Policies

Policy and legislation regarding water resources consider services derived from aquatic ecosystems and their connection with well-being and poverty reduction. Policies recognize the need to guarantee water quality and equitable access. All countries have formulated policies and regulatory frameworks for water resources, incorporating aspects such as integrated river basin management,

sewage management, and conservation of strategic watersheds.

Countries have developed financial mechanisms to conserve water resources. In Colombia, legislation created instruments such as requiring power companies to pay for protection of rivers and restoration or rehabilitation of water sources. The Brazilian Water Law (Law 9433 of 1997) establishes charges for water use with fees used for watershed and forest conservation. Water conservation is part of National Environmental Legislation in Ecuador. It provides voluntary mechanisms such as the Fund for the Protection of Water (FONAG), a private fund in operation since 2000, which, “uses the profits from its investments to jointly finance [...] rehabilitation, conservation and maintenance of the watersheds, from which the inhabitants of the Metropolitan District of Quito and its area of influence obtain the water they require for all their human and production needs”. Reforestation is highlighted within FONAG through actions such as the ones in Guayllabamba watershed, Pichincha province, where more than 1,300 ha are planted with native species. This watershed supplies most of the drinking water of the Metropolitan District of Quito and its wider area of influence. FONAG also sponsors programs of environmental education and monitoring of water resources in protected areas, and provides training programs in the integrated management of watersheds. Given the positive impact, several municipalities aim to replicate these FONAG-funded programs.

5.4.2.4. Conclusions

There is now considerable environmental legislation that acknowledges the importance of ecosystem services and their connection to well-being. Needed are strategies that support such policies at different scales and that seek both ecosystem services and improved well-being. The case studies presented in Chapter 4 consider management options, relationships with national, local and regional policies, and the improvement of the quality of life.

International and national efforts currently favour policies that deal with payment and compensation for ecosystem services. Yet, a great deal of efforts is still needed to consolidate this approach. Consolidation can be promoted through opportunities such as the creation of small funds easily accessible to support conservation units such as protected areas to achieve the RAMSAR status because of the services provided. Stakeholders in the present study stressed the importance of guidelines for such payments at a regional scale. Organizations such as ACTO and CAN might become a platform for integrating and harmonizing initiatives on ecosystem services and well-being in the Andes-Amazon region.

There is an opportunity for institutions such as NERC, DFID, and ESRC to promote and develop mechanisms that contribute to reduced climate change and promote equitable access to resources by local communities. In the Amazon, REDD projects such as the Bolsa Floresta promoted by the Brazilian state of Amazonas could facilitate maintenance and conservation of endangered ecosystems. The Andean region presents opportunities to support projects under the Clean Development Mechanism (CDM). Those opportunities will be influenced by ecological and institutional factors such as the nature and objectives of the PES mechanisms and the type of ecosystems services provided in each region. Maintenance of the existing carbon stocks in the Amazon through REDD projects could facilitate maintenance and conservation of endangered ecosystems and will help to reduce carbon emissions due to deforestation. In the Andean region, reforestation projects under the CDM will constitute the main sources of payment mechanisms for greenhouse gases' capture service.

PES and REDD will not work everywhere. Especially where the opportunity costs of conservation are extremely high (e.g., high value timber or soybean production) it is unlikely that payments can be offered to compensate for the foregone benefits of forest conversion. Moreover, lacking tenure

information and insecure property rights will limit direct payments to areas where such minimum conditions cannot be guaranteed. The establishment of protected areas, such as extractive reserves and indigenous lands may be a solution where pressure on forests is low and/or where control and enforcement are efficient. In high pressure areas, where forest conversion is highly profitable, solutions may lie in low impact technological innovations, certification schemes and environmental regulation. As mentioned in Chapter 3, research is needed that further establishes the conditions under which particular policies and their MO components are likely to work best and, on the basis of this, identifies priority intervention sites for pilot experiences.

Key issues to be addressed by ESPA: Stakeholder opinions and policy review

1. Widespread multi-stakeholder participation at all stages of policy research and follow up.
2. Emphasis on ES relevant to local communities considering traditional knowledge.
3. Definition and measurement of ES and well-being based on local level considerations.
4. Analysis of spatial and temporal dimensions of ES provision.
5. Establishment of stakeholder specific baselines and indicators as part of the monitoring of ES and impacts on well-being.
6. Incorporation of lessons learned from ongoing studies regarding ES in the design of new research and capacity-building initiatives.
7. Inclusion of relevant ecosystem services not encompassed in the legal frameworks of the Andean-Amazonian region (e.g., pollination and pest control services).
8. Promote training and capacity building in ecosystem services and well-being while strengthening already existing programs and local, national, and international initiatives.
9. Promote the restoration of degraded ecosystems in order to improve the provision of basic ES for poor or vulnerable communities.
10. Regional-level analysis of impacts of policies and related management options on ES provision and well-being under changing economic and environmental conditions (scenario analysis).

6. Conclusions and recommendations

The starting point of this situation analysis was that for the Andes/Amazon (albeit more so for the Amazon), levels of ES are high and poverty low compared to other study areas of the ESPA Program such as sub-Saharan Africa and South and SE Asia. Chapter 2 confirmed this, but showed where and to what extent important local and global ES are threatened. Chapters 4 and 5 made a case for the potential of cultural ES (not measured in Chapter 2 due to limitations in data availability) to contribute to poverty alleviation and prevention, especially in the Andes. In general, ES with local direct use values (e.g., forest products, water quantity/quality, local climate regulation, soil productivity and fish resources) are most important for the well-being of the poor. With some exceptions, the urban poor are less directly dependent on these ES, but they might be affected, through value chain effects, if ES such as soil and water quality, deteriorate. The Andes/Amazon region is rich in globally valued ES (e.g., carbon retention in forests, and biodiversity related ES) and probably at a comparative advantage in providing these at low costs. However, until today, this has resulted in very few tangible benefits for small-scale producers and traditional/indigenous inhabitants, many of which belong to the rural low-income groups. Clearly, part of the reason lies in the unequal distribution of the land that provides both global and locally valued ES and in the lack of well-defined land-tenure, a frequent requirement for indirect benefits of global ES to be channeled to local ES modifiers. That said, this situation analysis indicates considerable scope for improving the way ES are managed (see Chapters 3 and 4), which represents a strategic entry point for the ESPA program in the Andes/Amazon.

An important result of this situation analysis is that resource and ES abundance do not necessarily mean that the poor are less vulnerable to changes in ES provision. In fact, the opposite has been the case where rural livelihoods heavily dependent on natural resources are dispossessed of this natural capital due to encroachment and unequal power relations, being expelled from their lands or forced to re-adapt to conditions of significantly lower resource availability. The struggle of these social groups can be aggravated by rapid changes in local ES provision, e.g., through accidental forest fires, large-scale deforestation, building of hydroelectric dams, irregular floods, and climate change induced droughts. ES dependent traditional populations are hit more than others by these events, as repeatedly attested by violent conflicts in the Andes/Amazon.

Another relevant distinction between the Andes/Amazon and the other ESPA study areas is the relatively strong level of social organization and grassroots participation in policy processes, including environmental policy. As a consequence, our research and capacity-building recommendations for the Andes/Amazon region emphasize investments in human and social capital for the *prevention* of ES degradation. To prevent and reduce poverty, such investments need to secure and reinforce natural resource access for those whose livelihoods traditionally depend on it. The challenge is that both poor and wealthier colonists (less than many traditional indigenous cultures) along the region's agricultural frontiers can and do have dramatic impact on ES provided from this globally important ecoregion. Roads, chain-saws, and slash-and-burn agriculture have been combined to initiate the process of deforestation and land use change - a process that often results in degraded pastures, concentration of wealth, and social marginalization in both rural and urban environments. Nonetheless, cases of successful sustainable resource management exist, that need to be better understood, strengthened, and scaled out.

The overall question remains: How to work with all stakeholders, particularly the poor and vulnerable communities, such that interventions enhance well-being without destroying valuable ecosystem services and the ability of ecosystems to provide such services?

Perhaps fortunately, the region as a whole features a high proportion of urban peoples, growing middle classes, and the continued expansion of a civil society that pushes towards the enforcement of fully developed citizenship rights. Hence, some of the poor may benefit more from the positive effects of globalization and social policies than through local level exploitation of environmental services. However, historical developments in the region suggest that many will not. Part of the answer to the above question, thus, is to better understand the functioning of the ecosystems and their services, and the complex and context specific livelihood strategies of the poor. This is needed in order to test and identify proper ways to introduce viable management options and integrate them in a sensible policy framework in a cost-effective manner. Often this will involve taking advantage of markets, and when appropriate, working in public-private partnerships.

Various forms of this answer have been around for some time, and this report includes recommendations that are meant to increase their effectiveness and impact. Yet, success in alleviating poverty and in reducing the impacts of the poor on their environment has been difficult to achieve. There is a continued need to better understand the Andes/Amazon ecosystems, the nature and expressions of poverty and livelihood strategies of the poor, and their inordinate environmental impacts. Equally relevant is to comparatively assess the convoluted processes associated with unequal power relations that have often resulted in economic stratification and social differentiation across the region. Local nuances encompass, among others, ethnicity, religion, occupation, and gender issues. Many projects and programs have introduced supposedly sound management options. Failures in terms of adoption and impact have followed and have often been dismissed as market failures, “resistance” on the part of the poor, lack of government support or commitment, and the like. Limitations in the understanding of the underlying social dynamics are seldom fully acknowledged as causes of failure.

A partial explanation for the lack of uptake of new technologies and management options is that most such options require intensification of land use. It is, however, critical to examine the extent to which individuals, households, and communities respond to economic and ecological conditions that are intertwined with power relations and political structures. Both actor-centered, and social-structural approaches would agree that intensification is costly and out of reach for most of the poor; certainly more costly than extensive options - whenever the agricultural frontier is not closed.

Few smallholders can rely on safety-nets that would allow to buffer against the risks involved in intensive input-based agriculture in remote forest environments. Well-known, time-tested, but extensive swidden agriculture, therefore, often represents the preferred option even if it implies migrating out into new forest margins after soils are exhausted. Policies to close the agricultural frontier need to establish farmers on already open land. To achieve this, even well designed policies will largely depend on two conditions. First, serious structural reforms need to address land inequality, especially in Brazil. And second, production technologies and management options that are technically feasible, culturally acceptable and economically competitive.

On that basis, policy makers need to establish a feasible balance of incentives and disincentives. Unfortunately, policy-based disincentives (taxation, fines, exclusion) have had a poor track record in the Andes/Amazon, mainly because are poorly enforced. Fortunately, in the case of the Amazon there is a growing willingness to pay for important global ES (e.g., the existence and option values of biodiversity and the reduction of emissions from deforestation). However, payment mechanisms have yet to be developed that can actually reach poor resource modifiers such that they can and do change practices that compromise ES provision. The Andes, where many payment schemes and compensation mechanisms have emerged in recent years, may provide important lessons learned for the Amazon. Systematic and comparative research is needed to make this happen.

The recommendations for research and capacity building developed in this report seek to find a

balance among scientific approaches and conservation and development strategies to protect local, regional and global ecosystem goods and services and prevent poverty related to their loss. Many management options with potential to achieve these objectives require adjustments in existing policy frameworks. Overall, the recommendations consider the region's predominant features, as follows:

1. Large-scale commercial interests are controlling increasing shares of the region's resources. As a result, large quantities of globally valued ES are lost and traditional populations and poor rural colonists face ever more limited resource access and degrading local ES. Consequently, also urban and peri-urban poverty increases and poses additional challenges to environmental and social policies.
2. At the same time, comparatively low (but growing) numbers of poor rural inhabitants can and often do have considerable negative effects on globally valued ES.
3. Many rural poor have adapted their livelihood strategies to abundant ES and may, therefore, be more vulnerable to abrupt changes in ES provision; a scenario that this report shows is realistic, and therefore threatens the survival and socio-cultural reproduction of indigenous and other traditional cultures.

The body of this document has provided a wealth of recommendations for research and capacity building. Below we have structured these issues and suggest priorities for biophysical, socioeconomic and interdisciplinary research in the ESPA Program. Based on these priorities and stakeholder consultations in the Andes/Amazon, we subsequently sketch out potential research projects with capacity-building components. We further provide hints on how project impact can be optimized.

6.1. Priorities for ESPA research and capacity building

To address its objectives in the Andes/Amazon, the ESPA Program should promote research and strengthen capacities in three priority areas:

1. Understanding and predicting spatial and temporal dynamics of key locally and globally valued ES (especially, forest products and fish resources, local and regional climate regulation, water quality/quantity, and carbon sequestration) with a special focus on:
 - Integrating traditional spatial scales of study (individual sites) to policy relevant regional scales such as the one addressed in this situation analysis. Also taking into account the important implications of geographic and environmental differences throughout the region on the development of *locally adaptive and effective* regional policies. Recognizing the impact of trans-frontier and trans-continental linkages especially for climate and water.
 - Identifying critical thresholds of change in the provision of ES due to human impacts (such as deforestation), climate change, and their interaction, and devising monitoring, prevention, adaptation, and mitigation measures to ensure that significant thresholds that would lead to increased poverty and vulnerability are not crossed through ecosystem mismanagement.
 - Developing and disseminating practical methods to monitor and document local changes in ES provision and spatial-temporal management support systems to identify the agents and processes driving such changes, as well as testing *in silico* preventative policy measures.

2. Understanding, measuring and valuing the contribution of locally important ES to generate well-being among heterogeneous local stakeholder groups, with a special focus on:
 - Developing and testing comparative frameworks to integrate ES-related welfare into region-wide index-based poverty measures.
 - Identifying and mapping location and stakeholder specific vulnerability, based on indicators of the state of ES provision, and threats' assessment.
 - Developing and disseminating methods and tools to forecast natural and policy-induced changes in ES provision and their likely impacts for local well-being, as well as to predict the effect of alternative management options to mitigate such impacts.
 - Establish and institutionalize a regional knowledge management platform on ES and well-being to support prioritization of local and regional policy initiatives through interdisciplinary research for development outputs.
3. Promote innovative approaches to reduce the transaction costs and strengthen the incipient implementation of incentive based management options for enhanced ES provision (e.g. certification/ecolabelling, payments for environmental services, ecotourism; as well as other novel MO) and conduct comparative research to extract lessons learned with a special focus on:
 - Globally and locally valued ES which are affected by externalities of local income generating activities.
 - How, where and for whom incentive-based management options need to be combined with enabling management options in order to maximize benefits for the poor.
 - Developing and disseminating decision-frame works and related tools for policy makers to decide where and under what conditions incentive-based management options will work and what can be done if minimum conditions are not in place.

The first area involves primarily biophysical, the second interdisciplinary, and the third primarily socioeconomic and policy research. The research projects sketched out below represent a synthesis of priorities indicated by stakeholders and the key messages of the analytical sections of this report. Projects fall into one or more of the three priority areas. Most, not all, include capacity-building components.

ESPA-AA Suggested Project 1

Projects / Goals

- Identifying minimum conditions for ecosystem stability in the Andes/Amazon

Research questions

- What are the expected impacts of climate change on local water availability and flows in the Andes/Amazon?
- Is forest cover critical to maintaining hydrological stability in the Amazon? If yes, what are the minimum criteria of forest cover (size, location, degree of fragmentation, etc.) to maintain hydrological stability? Is the current protected areas' network sufficient for maintaining ecosystem stability?
- What is the relative importance of climate change and deforestation in promoting Amazon dieback? Under what conditions could dieback be avoided or mitigated given that climate change is inevitable?

Location/Approach

- Regional and trans-frontier research necessarily involving formal scenario analysis and field measurements

Impact Pathway

- ESPA research needs to link into existing initiatives (e.g., LBA, national research programs) and promote regional cooperation and networks.
- Results need to be fed into projects (3, 5) to assess the economic impact of key scenarios and inform policy makers

Capacity-building component

- Ideally this ESPA component provides incentives for regional cooperation. It could generate a critical mass for developing and maintaining open access regional climate and hydrological data bases and thereby enhance the capacity of scientist to take regional instead of national level perspectives.

ESPA-AA Suggested Project 2

Projects / Goals

- Defining sustainable levels of timber and non-timber forest product extraction and related minimum technological requirements

Research questions

- Given current technology, what are sustainable rates of extraction for important forest products?
- Do extraction technologies differ across stakeholder categories, and if yes, which elements of existing technologies allow for higher rates of extraction without compromising ecosystem functions?
- What are minimum biophysical conditions for non-forest based production systems to coexist with forest product extraction (e.g., fragmentation due to slash-and-burn agriculture and timber extraction)?

Location/Approach

- Selected official indigenous territories and extractive reserves. Other locations needed to be identified in cooperation with project (3). Maps in section 2.7.1.2 may serve as a starting point.

Impact Pathway

- Results are relevant for both policy planners and local or community based resource management initiatives.
- Explicit links to both should be established prior and maintained throughout project implementation.
- Project activities will require building inventories of forest products, which can be a powerful means of negotiating community support.

Capacity-building component

- Involvement of local decision-makers and extractivist communities is generally seen as a precondition to achieve real ownership (e.g. of inventories and planning methods). Since local and traditional knowledge are key to this project, it can contribute to building capacity among extractivists to integrate technology and traditional knowledge more efficiently.
- Communities will not be able to maintain and expand inventories on their own. Hence capacities for planning and database management need to be developed in local government and non-government organizations as well.

ESPA-AA Suggested Project 3

Projects / Goals

- Regional assessment of human vulnerability to variability and changes in ES provision

Research questions

- Which locally valued ES are important for which stakeholder groups and where?
- Which expected changes in local ES provision are relevant for which stakeholder groups, where and when? E.g., how will climate change impact on the water based environmental services, in particular for transport and HEP generation?
- Where, when and for whom will changes in local ES provision imply increased poverty?

Location/Approach

- Chapter 2 provides important hints mainly on the spatial dimensions of these questions. This project builds on results from projects (1) and (2) and is relevant for both the Andes and the Amazon. High spatial resolution is important especially in the Andes where ES provision is very heterogeneous.

Impact Pathway

- Changes implying increased poverty are very relevant to policy. To have impact, this project requires links to national and regional decision-makers. Results need to be communicated in accessible language at higher policy levels and form the basis for activities put forward in projects (4,5,6).

Capacity-building component

- This project is inherently interdisciplinary. Research in the Andes/Amazon has historically been dominated by disciplines. The ESPA Program could provide incentives for national research institutions to link up with international research centers and develop new interdisciplinary and participatory vulnerability mapping tools and related capacities.
- To establish such tools in national research agendas, cooperation with higher education institutions is necessary. Participation of local students (tomorrow's decision-makers) is desirable.

ESPA-AA Suggested Project 4

Projects / Goals

- Monitoring and forecasting ES provision for policy planning and adaptation to climate change and variability

Research questions

- Which changes in ES flows can be forecast and how?
- Is forecasting cost-effective and if yes, for which ES and where?
- Is a region-wide nowcasting system for important and poverty-relevant ES a realistic future scenario?

Location/Approach

- This project builds on the previous and needs to take a regional perspective to satisfyingly answer the research questions. An interdisciplinary approach is necessary to make sure results are policy relevant (question 2).

Impact Pathway

- The energy and transport sector, especially in the Amazon, but also commercial agriculture can be expected to be willing to pay for forecast information.
- Mechanisms could be developed at relatively low costs to allow for the poor to "free-ride" on improved forecast information (e.g. through local television and radio programs).

Capacity-building component

- As in the previous project, capacities may be developed in this project by involving higher education institutions in conducting research and tool development.

ESPA-AA Suggested Project 5

Projects / Goals

- Developing and disseminating knowledge, methods and decision tools to evaluate ES / well-being trade-offs of economic and ES-specific policy measures.

Research questions

- How can results from ESPA and related research be better integrated in local, national, and regional decision-making processes?
- Which type of information and knowledge (data, skills, methods) do decision-makers need to better evaluate trade-offs between ES and other development objectives
- How can this information be made available to decision-makers?

Location/Approach

- This project is the logical last step of an impact oriented ESPA approach. Knowledge needs to be managed more efficiently and has to be accessible to both researchers and decision-makers in adequate forms.
- Again, a regional approach is necessary and existing mechanisms to promote the regional policy dialogue (see Chapters 3 and 5) need to be strengthened.

Impact Pathway

- Although decisions are often made on political grounds, better information on ES / well-being relationships can make a difference, if can be used in political negotiation processes. The ESPA program can contribute by providing tools and knowledge for environmental policy makers to quantify the tradeoffs involved in making decisions that compromise ES.

Capacity-building component

- To develop useful decision tools, researchers need to involve decision-makers and make sure they provide useful knowledge.
- It is important to train technical staff in both government and non-government institutions in using decision-tools and knowledge management systems.
- Methods and tools that can successfully be integrated in university curricula are likely to be the preferred choices of future professionals.

ESPA-AA Suggested Project 6

Projects / Goals

- Identifying necessary biophysical, socioeconomic and institutional conditions for pro-poor incentive-based ES management (e.g., conditional cash transfer (PES), certification/ecolabelling, ecotourism, etc.)

Research questions

- Which are the necessary biophysical, socioeconomic, and institutional preconditions for incentive-based ES management options to achieve specific ES objectives in the Andes/Amazon?
- Which global and locally valued ES can realistically be addressed through incentive-based management options?
- Under which conditions are these mechanisms poverty neutral and well-being enhancing?
- How can incentive-based MO be made (e.g., through integration with enablement MO, see Chapter 3) pro-poor?

Location/Approach

- This project addresses key issues for the ESPA Program. It also reflects the current debate on payment based mechanisms, such as Reduced Emissions from Deforestation and Degradation (REDD). The approach should therefore be regional and based on the conceptual basis provided by the literature cited in Chapter 3.

Impact Pathway

- Many incentive-based management options still need to demonstrate that they can work. Promoting pilot experiences is, therefore, considered crucial.
- Many local and national policy-makers are interested in these mechanisms. This momentum should be used to achieve impact.
- Comparative research frameworks are needed to scale up results and make sense of individual experiences, success and failure.

Capacity-building component

- Implementing incentive-based management options requires new and often lacking capacities, especially at local level.
- With incentive-based mechanisms often comes the need for local governments to compete for funds in increasingly decentralized governance systems.
- Apart from communicating results to non-scientists it is, hence, necessary to strengthen institutional and administrative capacities and link local policy-makers to international funding sources.

7. References

- Abdallah, S., S. Thompson, & N. Marks, N. (2008). Estimating worldwide life satisfaction. *Ecological Economics*, 65:35-47
- Agrawal, A. & K. Gupta. (2005). Decentralization and Participation: The Governance of Common Pool Resources in Nepal's Terai. *World Development*, 33, 1101-1114.
- Agudelo, C., B. Rivera, J. Tapasco, & R. Estrada. (2003). Designing policies to reduce rural poverty and environmental degradation in a hillside zone of the Colombian Andes. *World Development* 31 (11): 1921–1931. 26: 2169– 2179.
- Alonso J. C., K. Camacho, M. Núñez, & E. Agudelo. (2008). Estado de los Recursos Hídricos e Hidrobiológicos en la Amazonia: Una Visión de Cuenca para los Países de la OTCA. En *GeoAmazonia 2008*. En prensa.
- Amend, M. R., J. Reid, & C. Gascon. (2006). Benefícios econômicos locais de áreas protegidas na região de Manaus, Amazonas. *Megadiversidade*, 2:60-70.
- Anderson, C. L., L. Locker, & R. Nugent. (2002). Microcredit, Social Capital, and Common Pool Resources. *World Development*, 30:95-105.
- Anderson, J. R. & J. Thampapillai. (1990). *Soil Conservation in Developing Countries: Project and Policy Intervention*. Washington D.C.: World Bank
- Ataroff, M. & F. Rada. (2000). Deforestation Impact on Water Dynamics in a Venezuelan Andean Cloud Forest. *Ambio*, 29:440–444.
- Auty, R. & A. Kiiski. (2002). Natural Resources, Capital Accumulation, Structural Change, and Welfare. In *Resource Abundance and Economic Development* (ed. R. Auty). Oxford University Press, Oxford.
- Avissar, R., & Y. Liu. (1996). Three-dimensional numerical study of shallow convective clouds and precipitation induced by land surface forcing. *Journal of Geophysical Research*, 101:7499-7518.
- Barthem, R. & M. Goulding. (1997). *The Catfish Connection: Ecology, Migration and Conservation of Amazonian Predators*. Columbia University Press.
- Baumol, W. J. & W. E. Oates. (1988). *The theory of environmental policy*, Second Edition. Cambridge University Press, New York.
- Bayon, R. (2001). *Innovating Environmental Finance*. Milken Institute.
- Belli, P., J. R. Anderson, H. N. Barnum, J. A. Dixon, & J. P. Tan. (2001). *Economic Analysis of Investment Operations: Analytical Tools and Practical Applications*. World Bank Institute Development Series. Washington, D.C.: World Bank. 264 p.
- Bonham-Carter, G. F., F. P. Agterberg, & D. F. Wright. (1989). Weights of evidence modelling: a new approach to mapping mineral potential. *Statistical Applications in Earth Sciences* 89 (9): 171-183.
- Bonham-Carter, G. F. (2002). Geographic information systems for geoscientist: Modelling with GIS. In: Merriam, D.F. (Ed.), *Computer Methods in the Geosciences*, vol. 13. New York: Pergamon/Elsevier, pp. 302-334.
- Börner, J., A. Mendoza, & S. A. Vosti. (2007). Ecosystem services, agriculture, and rural poverty in the Eastern Brazilian Amazon: Interrelationships and policy prescriptions. *Ecological Economics*, 64:356-373.

- Bosquet, B. (2000). Environmental tax reform: does it work? A survey of the empirical evidence. *Ecological Economics*, 34: 19-32.
- Brouwer, F. & P. Lowe. (2000). *CAP Regimes and the European Countryside*. CAB International
- Brown, S. & A. E. Lugo. (1992). Above-ground biomass estimates for tropical moist forests of the Brazilian Amazon. *Interciencia* 17(1): 8-18.
- Bruce, N. & G. M. Ellis. (1993). *Environmental Taxes and Policy for Developing Countries*. Washington D.C.: World Bank.
- Burgos, J. J., H. F. Ponce, & L. C. B. Molion. (1991). Climate change predictions for South America. *Climatic Change*, 18:223-239.
- Cernea, M. M. & K. Schmidt-Soltau. (2006). Poverty risks and national parks: Policy issues in conservation and resettlement. *World Development*, 34:1808-1830.
- Chambers, J. Q., N. Higuchi, E. S. Tribuzy, & S. E. Trumbore. (2001). Carbon sink for a century. *Nature* 410:429
- Chang, L. L. & R. S. Rajan. (2001). Regional Versus Multilateral Solutions to Transboundary Environmental Problems: Insights from the Southeast Asian Haze. *The World Economy*, 24:655-671.
- Charlier, R. H. (2003). A "sleeping" awakes: tidal current power. *Renewable and Sustainable Energy Reviews*, 7:515-529.
- Charney, J. G. (1975). Dynamics of deserts and drought in Sahel. *Quart. J. Royal Meteor. Soc.*, 101:193-202.
- Chomitz, K. M. & T. S. Thomas. (2003). Determinants of Land Use in Amazonia: A Fine-Scale Spatial Analysis. *American Journal of Agricultural Economics*, 85:1016-1028.
- Chu, P. S., Z. P. Yu, & S. Hastenrath. (1994). Detecting climate change concurrent with deforestation in the Amazon basin: Which way has it gone? *Bulletin of the American Meteorological Society*, 75:579-583.
- CIFOR (2005). *Forests and floods: drowning in fiction or thriving on facts*. Rap publication 2005/03 Forest Perspectives 2. ISBN 979-3361-64-6
- Clark, D. A. (2002). Are Tropical Forests an Important Carbon Sink? Reanalysis of the Long-Term Plot Data Ecological Applications, Vol. 12, No. 1 (Feb., 2002), pp. 3-7
- Consejo Boliviano para la Certificación Forestal Voluntaria (CFV). (2006). *Operaciones de manejo forestal en Bolivia*. <http://www.consejoforestal.org.bo>
- Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, & M. van den Belt. (1997). The value of the world's ecosystem services and natural capital. *Nature*, 387:253.
- Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, & M. van den Belt. (1998). The value of the world's ecosystem services and natural capital (Reprinted from *Nature*, vol 387, pg 253, 1997). *Ecological Economics*, 25, 3-15.
- D'Almeida, C., C. J. Vorosmarty, G. C. Hurt, J. A. Marengo, S. L. Dingman, & B. D. Keim. (2007). Review: The effects of deforestation on the hydrological cycle in Amazonia: a review on scale and resolution. *International Journal of Climatology*. 27: 633-647.
- Daily, G. C., ed. (1997). *Nature's services: Societal dependence on natural ecosystems*. Island Press. Washington, D.C.

- Debinski, D. M. & R. D. Holt. (2000). A Survey and Overview of Habitat Fragmentation Experiments. *Conservation Biology*, 14:342-355.
- DFID. (2005). From the Mountain to the Tap: How Land Use and Water Management Can Work for the Rural Poor. http://www.frp.uk.com/assets/Water_book.pdf
- DFID. (1999). Livelihoods approaches compared. A brief comparison of the livelihoods approaches of the UK (DDFID), CARE, OXFAM, and the United Nations Development Programme (UUNDP). DFID. 19 p.
- Dietz, T., E. Ostrom, & P. C. Stern. (2003). The Struggle to Govern the Commons. *Science*, 302:1907-1912.
- Engel, S. & C. Palmer. (2008). Payments for environmental services as an alternative to logging under weak property rights: The case of Indonesia. *Ecological Economics*, 65(4): 799-809.
- Fa, J. E., C. A. Peres, & J. Meewig. (2002). Bushmeat Exploitation in Tropical Forests: an Intercontinental Comparison. *Conservation Biology*, 16:232-237.
- Fearnside, P. M. (2001). Land-Tenure Issues as Factors in Environmental Destruction in Brazilian Amazonia: The Case of Southern Pará. *World Development*, 29, 1361-1372.
- Fearnside, P. M. (1997). Wood density for estimating forest biomass in Brazilian Amazonia. *Forest Ecology and Management*, 90(1):59-87
- Feddema, J. J., K. W. Oleson, G. B. Bonan, L. O. Mearns, L. E. Buja, G. A. Meehl, & W. M. Washington. (2005). The Importance of Land-Cover Change in Simulating Future Climates. *Science*, 310:1674-1678.
- Ferraro, P. J., T. Uchida, & J. M. Conrad. (2005). Price premiums for eco-friendly commodities: Are 'Green' markets the best way to protect endangered ecosystems? *Environmental & Resource Economics*, 32: 419-438.
- FSC Brasil (Conselho Brasileiro de Manejo Florestal). (2008). Operações de florestas certificadas no Brasil. http://www.fsc.org.br/arquivos/2008.04.02%20Florestas_certificadas_FSC.xls
- Gery, J. (1984). The Fishes of Amazonia. In: Sioli, H., ed., *The Amazon: Limnology and Landscape Ecology of a Mighty Tropical River and Its Basin*. Dr. W. Junk, Pub., Netherlands. 763 p.
- GLCF. (2008). The Global Land Cover Facility (GLCF) Data Products and Satellite Imagery. University of Maryland. http://gcmd.nasa.gov/records/01-global_land_cov_facility-00.html
- Granado, L. C. (1987). Estimaciones de número y biomasa íctica en el embalse de Torrejón (Río Tajo) desde 1982 a 1986. *Revista: Ecología*, 1: 257-262
- Gray, L. C. & W. G. Moseley. (2005). A geographical perspective on poverty-environment interactions, Vol. 171, pp. 9-23.
- Green, E. & R. Donnelly. (2003). Recreational Scuba Diving in Caribbean Marine Protected Areas: Do The Users Pay? *Ambio*, 32:140–144.
- Guerra, H., F. Alcantara, J. Maco, & H. Sánchez. (1990). La pesquería en el Amazonas peruano. *Interciencia*, 15 (6):469-475
- Hansen, M. C., R. S. DeFries, J. R. G. Townshend, M. Carroll, C. Dimiceli, & R. A. Sohlberg. (2003). Global Percent Tree Cover at a Spatial Resolution of 500 Meters: First Results of the MODIS Vegetation Continuous Fields Algorithm. *Earth Interactions*, 7:1-14.
- Harris, P.J. C., A. W. Browne, H. R. Barret, & K. Cadoret. (2001). Facilitating the Inclusion of the Resource-Poor in Organic Production and Trade: Opportunities and Constraints Posed by Certification. UK Department for International Development, DFID.

- Hayes, T. M. (2006). Parks, people, and forest protection: An institutional assessment of the effectiveness of protected areas. *World Development*, 34:2064-2075.
- Hazell, P., C. Pomareda, & A. Valdés. (1986). *Crop Insurance for Agricultural Development*. The John Hopkins University Press.
- Holling, C. S. & G. K. Meffe. (1996). Command and Control and the Pathology of Natural Resource Management. *Conservation Biology*, 10:328-337.
- Hotte, L. (2001). Conflicts over property rights and natural-resource exploitation at the frontier. *Journal of Development Economics*, 66:1-21.
- Houghton R. A., D. L. Skole, C. A. Nobre, J. L. Hackler, K. T. Lawrence, W. H. Chomentowski. (2000). Annual fluxes of carbon from deforestation and regrowth in the Brazilian Amazon. *Nature*, 403 (6767): 301-4.
- Huber, R. M., J. Ruitenbeek, & R. S. d. Motta. (1998). *Market-Based Instruments for Environmental Policymaking in Latin America and the Carribean*. Washington D.C.: World Bank.
- IFAD. (2003). *Transforming Rural Institutions in Order to Reach the Millennium Development Goals*. IFAD.
- Iftikhar, U. A., M. Kallesoe, A. Duraiappah, G. Sriskanthan, S. V. Poats, & B. Swallow. (2007). Exploring the inter-linkages among and between Compensation and Rewards for Ecosystem Services (CRES) and human well-being.No.1.
- Jarvis, A., S. E. Castaño, G. Hyman, S. Gebhardt, E. Guevara, M. Castro, J. Touval, & L. Sotomayor. (2008). *Project Report: TNC Threats Assessment Version 2. The Nature Conservancy and Centro Internacional de Agricultura Tropical*.
- Johnstone, N. & J. R. R. Alavalapati. (1998). The distributional effects of environmental tax reform. *IIED Catalogue*.
- Jones, P. G, W. Diaz, & J. H. Cock. (2005). *Homologue: A Computer Systems for Identifying Similar Environments throughout the Tropical World*. Centro Internacional de Agricultura Tropical. 98 p.
- Kellert, S. R., J. N. Mehta, S. A. Ebbin, & L. L. Lichtenfeld. (2000). Community Natural Resource Management: Promise, Rhetoric, and Reality. *Society & Natural Resources*, 13:705-715.
- Kollmuss, A. & J. Agyeman. (2002). Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, 8:239-260.
- Kremen, C. (2005) Managing ecosystem services: what do we need to know about their ecology? *Ecology Letters*, 8:468-479.
- Kroeger, T. & F. Casey. (2007). An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecological Economics*, 64: 321-332.
- Kuyvenhoven, A. (2004). Creating an enabling environment: policy conditions for less-favored areas. *Food Policy*, 29:407-429.
- Landell Mills, N. & I. Porras. (2002). Silver bullet or fool's gold? A global review of markets for forest environmental services and their impact on the poor. *IIED Catalogue*.
- Laurance, W. F., A. K. M. Albernaz, G. Schroth, P. M. Fearnside, S. Bergen, E. M. Venticinque, & C. da Costa. (2002). Predictors of deforestation in the Brazilian Amazon. *Journal of Biogeography*, 29:737-748.
- Laurance, W. F., M. A. Cochrane, S. Bergen, P. M. Fearnside, P. Delamônica, C. Barber, S. D'Angelo, & T. Fernandes. (2001). The Future of the Brazilian Amazon. *Science*, 291(5503):438-439

- Lee, D. R. & C. B. Barrett, eds. (2001). Tradeoffs or Synergies? Agricultural Intensification, Economic Development and the Environment. CAB International Publishing.
- Leopoldo, P. R., W. K. Franken, & N. A. Villa Nova. (1995). Real evapotranspiration and transpiration through a tropical rain forest in central Amazonia as estimated by the water balance method. *For. Ecol. Manage.* 73:185-195.
- Loreau, M., S. Naeem, J. Inchausti, J. Bengtsson, J. P. Grime, A. Hector, D. U. Hooper, M. A. Huston, D. Raffaelli, B. Schmid, D. Tilman, & D. A. Wardle. (2001). Biodiversity and Ecosystem Functioning: Current Knowledge and Future Challenges. *Science*, 294:804-808.
- Lowe, P., K. Falconer, I. Hodge, A. Moxey, N. Ward, & M. Whitby. (1999). Integrating the Environment into CAP reform. University of Newcastle, Department of Agricultural Economics and Food Marketing.
- Lubell, M., M. Schneider, J. T. Scholz, & M. Mete. (2002). Watershed Partnerships and the Emergence of Collective Action Institutions. *American Journal of Political Science*, 46:148-163.
- Malhi, Y., J. Timmons Roberts, R. A. Betts, T. J. Killeen, W. Li, & C. A. Nobre. (2008). Climate change, deforestation and the fate of the Amazon. *Science*, 319:169-172.
- Malhi, Y., D. Wood, T. R. Baker, J. Wright, O. L. Phillips, T. Cochrane, P. Meir, J. Chave, S. Almeida, L. Arroyo, N. Higuchi, T. J. Killeen, S. G. Laurance, W. F. Laurance, S. L. Lewis, A. Monteagudo, D. A. Neill, P. N. Vargas, N. C. A. Pitman, C. A. Quesada, R. Salomão, J. N. M. Silva, A. T. Lezama, J. Terborgh, R. V. Martínez, & B. Vinceti. (2006). The regional variation of aboveground live biomass in old-growth Amazonian forests. *Global Change Biology* 12(7):1107-1138
- Malhi, Y., T. R. Baker, O. L. Phillips, S. Almeida, E. Alvarez, L. Arroyo, J. Chave, C. Czimczik, A. Di Fiore, N. Higuchi, T. Killeen, S. G. Laurance, W. F. Laurance, S. Lewis, L. M. Mercado, A. Monteagudo, D. Neill, V. P. Núñez, S. Patiño, N. C. A. Pitman, A. Quesada, N. Silva, A. Torres Lezama, J. Terborgh, M. R. Vásquez, B. Vinceti, & J. Lloyd, J. (2004). Wood productivity and net primary productivity in 100 neotropical forests. *Global Change Biology* 10, 563-591.
- Marland, G., M. Obersteiner, & B. Schlamadinger. (2007). The Carbon Benefits of Fuels and Forests. *Science* 18(5853):1066-1068
- May, P. (1991). Building institutions and markets for non-wood forest products from the Brazilian Amazon. *Unasylva*, 165.
- McGarigal & Marks. (1994). Fragstats: Spatial pattern analysis program for quantifying landscape structure. Reference manual. For. Sci. Dep. Oregon State University. Corvallis Oregon 62 p.+ Append.
- McGrath, D., F. de Castro, C. Fudemma, B. de Amaral, & J. Calabria. (1993). Fisheries and the evolution of resource management on the lower Amazon floodplain. *Human Ecology*, 21:167-195.
- Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: Biodiversity Synthesis. Washington, D.C.: World Resources Institute.
- Merona, B. (1993). Pesca e ecología dos recursos acuáticos na Amazônia. En: Povos das águas: Realidade e perspectivas na Amazonia. 292 p.
- Montreuil, V. H., J. Maco, F. Alcantara, H. Guerra, & S. Tello. (1991). Análisis Situacional de la Pesquería en la Amazonia Peruana. Mimeo. Iquitos, Peru: IIAP.
- Montreuil, F. V., B. D. Muñoz, & D. G. Vargas. (2003). Variaciones en la composición de las comunidades ícticas en el bajo Ucayali. *Memorias: Manejo de Fauna silvestre en Amazonia y Latinoamérica*. 7 p.

- Moran, D., D. Pearce, & A. Wendelaar. (1996). Global biodiversity priorities: A cost-effectiveness index for investments. *Global Environmental Change*, 6:103-119.
- Muller-Karger, F. E., C. R. McClain, & P. L. Richardson. (1988). The dispersal of the Amazon's water. *Nature*, 333:56-59.
- Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. da Fonseca, & J. Kents. (2000). Biodiversity hot-spots for conservation priorities. *Nature* 403:853–858.
- Nail, E. L., D. L. Young, & W. F. Schillinger. (2007). Government subsidies and crop insurance effects on the economics of conservation cropping systems in eastern Washington. *Agronomy Journal*, 99:614-620.
- Nelson, A., T. Oberthür, & S. Cook. (2007). Multi-scale correlations between topography and vegetation in a hillside catchment of Honduras. *International Journal of Geographical Information Science* 145-174.
- Nepstad, D. C, C. M. Stickler, B. S. Filho, & F. Merry. (2008). Interactions among Amazon land use, forests and climate: prospects for a near-term forest tipping point. *Phil. Trans. R. Soc. B.*, 363:1737-1746.
- Nepstad, D., B. Soares-Filho, F. Merry, P. Moutinho, H. O. Rodrigues, M. Bowman, S. Schwartzman, O. Almeida, & S. Rivero. (2007). The Costs and Benefits of Reducing Carbon Emissions from Deforestation and Forest Degradation in the Brazilian Amazon. The Woods Hole Research Center. United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP), Thirteenth session. 3-14 December 2007.
- NEF (2006). The Happy Planet Index: An index of human well-being and environmental impact. The New Economic Foundation, London, United Kingdom. 59 p.
- Nunes, P. & Y. Riyanto. (2001). Policy Instruments for Creating Markets for Biodiversity: Certification and Ecolabelling. In Social Science Research Network Electronic Paper Collection, Vol. NOTA DI LAVORO 72.2001.
- Oenema, O., B. H. Janssen, E. Smaling, & E. Hoffland. (2006). Nutrient management in tropical agroecosystems. *Agriculture, Ecosystems & Environment*, 116:1-3.
- Ostfeld, R.S, & F. Keesing. (2000). Biodiversity and Disease Risk: the case of Lyme Disease. *Conservation Biology* 14(.3):722-728
- Ostrom, E., J. Burger, C. B. Field, R. B. Norgaard, & D. Policansky. (2005). Revisiting the Commons: Local Lessons, Global Challenges. In *Evolutionary Perspectives on Environmental Problems* (eds. D.J. Penn & I. Myrsetrud). Transaction Publishers, New Jersey.
- Otero, M., J. Rubiano, G. Lema, & V. Soto. (2006). Using similarity analyses to scale out research findings. *Water International* (31):3
- Pagiola, S. (2007). Payments for environmental services in Costa Rica. *Ecological Economics*, 6(5):712-724
- Pagiola, S., A. Arcenas, & G. Platais. (2005). Can Payments for Environmental Services Help Reduce Poverty? An Exploration of the Issues and the Evidence to Date from Latin America. *World Development*, 33:237-253.
- Pagiola, S., J. Bishop, & N. Landell Mills. (2003). Selling Forest Environmental Services: Market-based Incentives for Conservation and Development. *Ecological Economics*, 45(2):311-312
- Palmer, J. A., J. Suggate, B. Bajd, P. Hart, R. K. P. Ho, J. K. W. Ofwono-Orecho, M. Peries, I. Robottom, E. Tsaliki & C. Van Staden. (1998). An Overview of Significant Influences and Formative Experiences on the Development of Adults. *Environmental Awareness in Nine Countries. Environmental Education Research*, 4:445 - 464.

- Pearce, D. W. & K. T. Turner. (1990). *Natural Resource and Environmental Economics*. Johns Hopkins University Press.
- Pfaff, A. S. P. (1999). What Drives Deforestation in the Brazilian Amazon?: Evidence from Satellite and Socioeconomic Data. *Journal of Environmental Economics and Management*, 37, 26-43.
- Poats, S. V. (2007). Report on the Latin American Regional Workshop on Compensation for Environmental Services and Poverty Alleviation in Latin America: April 26 – 28, 2006, Quito, Ecuador. ICRAF Working Paper no. 33. World Agroforestry Centre, Nairobi, Kenya.
- Polasky, S., G. Daily, P. Kareiva, N. T. Ricketts, E. Regetz, J. G. Mendoza, H. Tallis, R. Naidoo, V. Adamowicz, D. Cameron, K. Chan, & R. Shaw. (2007). The Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Tool: A modeling suite developed by the Natural Capital Project to support environmental decision – making. Natural Capital Project. Stanford, CA: Stanford University Press.
- Portney, P. R. & R. N. Stavins. (2000). *Public Policies for Environmental Protection*. Washington D.C.: Resources for the Future.
- Qaim, M., A. Subramanian, G. Naik, & D. Zilberman. (2006). Adoption of Bt Cotton and Impact Variability: Insights from India, 28:48-58.
- Ravnborg, H. M. & M. d.P. Guerrero. (1999). Collective action in watershed management -- experiences from the Andean hillsides. *Agriculture and Human Values*, 16:257-266.
- Ravnborg, H. M. (2003). Poverty and Environmental Degradation in the Nicaraguan Hillsides. *World Development*, 31:1933-1946.
- Richey, J. E., C. A. Nobre, & C. Deser. (1989). Amazon River Discharge and Climate Variability: 1903 to 1985, Vol. 246, pp. 101-103.
- Riofrío J. C. (1998). Características de la Pesquería Comercial de Consumo en Pucallpa (Ucayali-Peru). *Revista de Investigaciones Pecuarias*, 9 (1):67-7
- Saatchi, S. S., R. A. Houghton, R. C. dos Santos Alvalá, J. V. Soares & Y. Yu. (2007). Distribution of aboveground live biomass in the Amazon basin *Global Change Biology*, 13 (4):816–837
- Salati, E. & C. A. Nobre. (1991). Possible Climatic Impacts of Tropical Deforestation. *Climatic Change*, 19:177-96
- Sayre, R., J. Bow, & C. Josse. (2005). Modeling NatureServe's Latin America and Caribbean Ecological Systems throughout South America. The Nature Conservancy and NatureServe.
- Schöngart, J. & W. J. Junk. (2007). Forecasting the flood-pulse in Central Amazonia by ENSO-indices.- *Journal of Hydrology* 335(1-2):124-132
- Schuck, E. C., W. Njanje, & D. Yantio. (2002). The role of land tenure and extension education in the adoption of slash and burn agriculture. *Ecological Economics*, 43: 61-70.
- Schwartzman, S. & B. Zimmerman. (2005). Alianças de conservação com povos indígenas da Amazônia. *Megadiversidade*, 1:165-173.
- Seroa da Motta, R. & C. A. Ferraz do Amaral. (2000). Estimating timber depreciation in the Brazilian Amazon. *Environment and Development Economics*, 5:129-142.
- Simula, M., J. Salmi, & E. Puustajärvi. (2002). Forest Financing in Latin America: The Role of the Inter-American Development Bank. Inter-American Development Bank, Washington D.C.
- Soares-Filho, B. S., D. C. Nepstad, L. M. Curran, G. C. Cerqueira, R. A. Garcia, C. A. Ramos, E. Voll, A. McDonald, P. Lefebvre, & P. Schlesinger. (2006). Modelling conservation in the Amazon basin. *Nature*, 440:520-523.

- Southgate, D. & R. Macke. (1989). The Downstream Benefits of Soil Conservation in Third World Hydroelectric Watersheds. *Land Economics*, 65:38-48.
- Southgate, D. & S. Wunder. (2007). Paying for Watershed Services in Latin America: A Review of Current Initiatives. Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM CRSP) and Office of International Research, Education, and Development (OURED), Virginia Tech.
- Sterner, T. (2003). Policy instruments for environmental and natural resource management. Washington D.C.: Resources for the Future.
- Sudirman, W. Dede, & H. Nely. (2005). Local Policy-making Mechanisms Processes, Implementation and Impacts of the Decentralized Forest Management System in Tanjung Jabung Barat District, Jambi, Sumatra. Bogor, Indonesia: Center for International Forestry Research (CIFOR).
- Swallow, B., M. Kallesoe, U. Iftikhar, M. van Noordwijk, C. Bracer, S. J. Scherr, K. V. Raju, S. Poats, A. Duraippah, B. Ochieng, H. Mallee, & R. Rumley. (2007). Compensation and Rewards for Environmental Services in the Developing World. Nairobi, Kenya: World Agroforestry Centre.
- Swallow, B., M.v. Noordwijk, S. Dewi, D. Murdiyarso, D. White, J. Gockowski, G. Hyman, S. Budidarsono, V. Robiglio, V. Meadu, A. Ekadinata, F. Agus, K. Hairiah, P. Mbile, D. Sonwa, & D. Weise. (2007). Opportunities for Avoided Deforestation with Sustainable Benefits. An Interim Report by the ASB Partnership for the Tropical Forest Margins, Nairobi, Kenya.
- Swinton, S. M., G. Escobar, & T. Reardon. (2003). Poverty and Environment in Latin America: Concepts, Evidence and Policy Implications. *World Development*, 31:1865-1872
- Tello, S. & P. Bayley. (2001). La Pesquería Comercial de Loreto con Énfasis en el Análisis de la Relación entre Captura y Esfuerzo Pesquero de la Flota Comercial de Iquitos, Cuenca del Amazonas (Perú). *Folia Amazónica*, 12 (1-2):123 -139
- Thünen, J. H.v. (1826). *Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie* Perthes, Hamburg.
- Toni, F. & Kaimowitz, D., eds. (2003). *Municípios e Gestão Florestal na Amazônia*. Natal, Brazil: A.S. Editores.
- Turner, W. R., Brandon, K., Brooks, T. M., Costanza, R., Da Fonseca, G. A. B., & Portela, R. (2007). Global Conservation of Biodiversity and Ecosystem Services. *Bioscience*, 57:868.
- Visseren-Hamakers, I. J. & Glasbergen, P. (2007). Partnerships in forest governance. *Global Environmental Change*, 17:408-419.
- Vosti, S. A. & T. Reardon, eds. (1997). Poverty-environment links in rural areas of developing countries. In *Agricultural sustainability, growth, and poverty alleviation: A policy and agroecological perspective*. Johns Hopkins University Press, Baltimore.
- Vosti, S. A., J. Witcover, & C. L. Carpentier. (2002). Agricultural Intensification by Small-holders in the Western Brazilian Amazon: From Deforestation to Sustainable Land Use. Washington, D.C.: International Food Policy Research Institute (IFPRI).
- Wunder, S., S. Engel, & S. Pagiola. (2008). Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. *Ecological Economics*, 65, 834-852.
- Wunder, S. (2000). Big island, green forests and backpackers. Land-use and development options on Ilha Grande, Rio de Janeiro state, Brazil, CDR Working Paper 00.3, March, Copenhagen: Centre for Development Research. 42pp.
- Wunder, S. (2007). Payments for environmental services and the poor: concepts and preliminary

- evidence. *Environment and Development Economics*, 13:279-297.
- Wunder, S., J. Börner, M. T. Rüginitz, L. Pereira, & N. Nascimento. (forthcoming): Pagamentos por serviços ambientais: Uma opção para a Amazônia Legal? Report prepared for the Brazilian Ministry of Environment. Belém, Brazil. WWF & TNC (2008). *Freshwater Ecoregions of the World*. January 2008.
- WWF, Incoder & Traffic. (2006). Aspectos Socioeconómicos y de Manejo Sostenible del Comercio Internacional de Peces Ornamentales de Agua Dulce en el Norte de Sudamérica. Retos y Perspectivas. *Memorias Taller Internacional*. 72 pag.
- Xue, Y. & J. Shukla. (1993). The influence of land surface properties on Sahel climate. *J. Climate*, 6:2232-45.
- Zaal, F. & R. H. Oostendorp. (2003). Explaining a Miracle: Intensification and the Transition Towards Sustainable Small-scale Agriculture in Dryland Machakos and Kitui Districts, Kenya. *World Development*, 30:1271-1287.
- Zeng, N., J. Yoon, J. A. Marengo, A. Subramaniam, C. A. Nobre, A. Mariotti, & J. D. Neelin. (2008). Causes and impacts of the 2005 Amazon drought. *Environmental Research Letters*, 3.
- Zimmerer, K. S. (1993). Soil Erosion and Labor Shortages in the Andes with Special Reference to Bolivia, 1953-91: Implications for "Conservation-With-Development" *World Development*, 21:1659-1675.

List of Annexes

- Annex 1 - Detailed tables of poverty and population in different land-uses**
- Annex 2 - Mapping Water quantity-based Ecosystem Services in the Amazon**
- Annex 3 - Reduction of climatic, hydrological and geomorphic hazards related Ecosystem Services in the Amazon**
- Annex 4 - Regulation of the climate system related Ecosystem Services in the Amazon**
- Annex 5 - Carbon related Ecosystem Services in the Amazon**
- Annex 6 - Mapping Spatial Patterns of Supply and Demand of Ecosystem Services in the Amazon Basin: Biodiversity**
- Annex 7 - Fish supply and consumption – Methodology and detailed Results**
- Annex 8 - Freshwater Ecosystem Assessment – Methods and Detailed Results**
- Annex 9 - Case studies and sources of information. Sources of information for case studies**
- Annex 10 - Previous experiences and advances in research on the topic of ecosystem services in Andean-Amazon countries.**
- Annex 11 - Entities offering training and capacity building programs in the ecosystem services area**
- Annex 12 - Policies in the Andes-Amazon region for water, forest, and protected areas**