OCCASIONAL PAPER

Ecosystem services certification

Opportunities and constraints

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Abbreviations

AF&PA	American Forest and Paper Association
CCBA	Climate, Community and Biodiversity Alliance
CDM	Clean Development Mechanism
CFS	CarbonFix Standard
CIFOR	Center for International Forestry Research
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
ES	ecosystem service(s)
FLO	Fairtrade Labelling Organizations International
FSC	Forest Stewardship Council
GEF	Global Environment Facility
ha	hectares
HCVF	high conservation value forest
InVEST	integrated valuation of ecosystem services and tradeoffs
ISO	International Organization for Standardization
ITTO	International Tropical Timber Organization
km	kilometre
LEI	Indonesian Ecolabelling Institute
MTCS	Malaysian Timber Council Scheme
NGO	nongovernmental organisation
NTFP	non-timber forest product
PEFC	Programme for the Endorsement of Forest Certification Schemes
PES	Payment for Ecosystem Services
PWS	Payment for watershed services
REDD	Reduced emissions from deforestation and forest degradation.
REDD+	Reduced emissions from deforestation, forest degradation, and supporting activities that might lead to ‘enhancing forest carbon stocks’, ‘sustainable management of forests’ and ‘conservation’.
RSPO	Roundtable on Sustainable Palm Oil
SFI	Sustainable Forest Initiative
SGS	Société Générale de Surveillance
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Voluntary Carbon Standard

Glossary

Certification for ecosystem services: There are three different ways to define certification of ecosystem services:

1. Certification of PES schemes to demonstrate they are 'sustainable' in terms of economic, social and environmental impacts;
2. Certification of PES schemes to demonstrate that they actually deliver ecosystem services from land use/ mgt (i.e. verification of service delivery); and
3. Certification that existing PES schemes or certification schemes e.g. carbon, timber etc. provide additional ecosystem services, other than what is being paid for e.g. watershed services from land-based carbon offset projects.

Because it is unclear in which direction certification of ecosystem services will develop (if anywhere), we do not strictly define this certification process in this report, and explore the different contexts in different sections of the report.

Payment for ecosystem services (PES): Following Wunder (2007), we define this as a voluntary transaction between at least one buyer and at least one seller, in which payments are conditional on maintaining an ecosystem use that provides well-defined environmental services.

Sustainability: The terms 'sustainability', 'sustainable development' and 'sustainable use' are frequently used in today's forest management and conservation literature, but often without clear definition. We recognise the difficulty of defining a fluid interactive process between social, environmental and economic factors. Any management intervention changes the overall system for good, and sustainability somehow needs to draw a line beyond which future generations would have 'significantly lower living standards', 'chronically higher risks' and would be deprived of key values they currently hold (Diamond 2005). For the purpose of this review we have chosen a definition by Barbier (1987) that seems to best fit the context of using ecosystem services 'to maximize simultaneously the biological system goals (genetic diversity, resilience, biological productivity), economic system goals (satisfaction of basic needs, enhancement of equity, increasing useful goods and services), and social system goals (cultural diversity, institutional sustainability, social justice, participation)'.

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Summary

The idea of developing certification systems for forest ecosystem services has broad support among nongovernmental groups. To ensure that the trading of ecosystem goods and services does not lead to ecological degradation and social conflict some commonly agreed principles of sustainable management need to be adhered to. Certification systems define the principles and criteria that are used to judge whether management is sustainable.

Within the context of the Forest Stewardship Council's (FSC) program to pilot certification of ecosystem services, this review analyses where constraints to effective implementation are likely to exist. This report primarily targets organisations interested in certification of ecosystem services as well as researchers of the subject.

Our analysis suggests that despite the simple concept of certifying ecosystem services, the practicalities are more daunting. For certification to work and be attractive to traders various barriers need to be overcome. We found that while carbon is a possible candidate for certification other ecosystem services currently pose challenges. Even for carbon, significant hurdles will have to be overcome before it can be reliably incorporated into a certification system that captures the requirements of measurement, verification, and monitoring, and guarantees the maintenance of the broader forest landscape.

For certification to generate adequate interest a market must exist with multiple sellers and buyers of ecosystem services. The costs of certification have to be lower than the opportunity plus transaction costs of trading without certification, otherwise there will be no financial incentive for certification. The high transaction cost of certification is one of the reasons why forest certification for timber and fibre has been slow to develop, especially in tropical forest countries. At least some of these costs are caused by the complexity of certification systems, which require expensive external input and significant investment from forest managers.

Direct market incentives are, however, not the only driver of certification. Other considerations, such as public relations, more efficient forest management, and improved relationships with local stakeholders may also be important, although these can also have market implications. Understanding where the demand for certification comes from—the seller, the buyer, the verifier or a combination—should help in deciding what kind of system would work best. Different stakeholders have different requirements for what a certification system should provide, and what criteria and indicators should address.

A major challenge in trading ecosystem services is the need to quantify and commoditise services, for monitoring and verification as well as trade. This is relatively straightforward for goods such as forest honey or shade-grown coffee, but potentially complex for services such as water purification, flood or disaster risk reduction, or carbon sequestration. Only for the latter is there sufficient scientific insight to link vegetation types, land use and management, with amounts of carbon stored and sequestered, providing a tradable value. Certification of such services does not necessarily require quantification, but it does require management plans to be developed to deliver on sustainability, which is likely to necessitate the collection of quantitative data, such as inventory data to determine harvest intensities. Reviews indicate that proven sustainability has yet to be achieved through forest certification, posing

significant challenges for the development of new certification systems. It can even be questioned whether sustainability can be a guiding operational concept for ecosystem services in a changing world, although existing forest certification systems are all based on this concept (FSC 2009).

The scale and geographic location of forest ecosystems are important factors in determining the success of various ecosystem services certification schemes Different certification schemes have had different success rates in the tropics versus temperate forests. In general the more complex certification systems, such as Forest Stewardship Council system, are more successful in temperate forests, especially among large industrial forest users. However, certification using simpler systems with lower thresholds has done relatively well in tropical forests, among smaller forest owners. These experiences offer important lessons, since improving forest management in tropical forests is one of the driving objectives behind certifying ecosystem services. The challenge is to develop relatively simple and cheap certification systems, with limited need for outside technical support, that are still robust enough to reliably quantify payments for ecosystem services and guarantee the sustainable management of forests.

Forest certification systems that are cheap and simple, and cover all criteria for sustainable and responsible forest management do not yet exist. This review discusses the potential use of more holistic concepts for measuring management sustainability, but these remain undeveloped and untested. Clearly further research is required. Can systems be developed that provide an overall view of sustainability without going into great detail about ways to achieve that sustainability? Such systems could serve as models to improve understanding of the practical implications of sustainability goals, which by definition are dynamic and interdimensional. If such working models could be developed, with reliable measurement and reporting of traded ecosystem services such as carbon, this would be a significant advance in the development of practical certification systems. Without these developments, certification of ecosystem services could go the way of certification of timber and fibre, i.e. implemented in areas where the benefits of certification are relatively small.

This review has identified several other areas requiring research. One obvious one, although mostly ignored in forest conservation science, is whether forest certification actually has a positive impact on forest biodiversity and other aspects of sustainable management. Also related to this question: are complex certification systems needed to achieve sustainable management outcomes, or can this be done in a more simple way?

In conclusion, although certification of ecosystem services appears a useful concept, many practical and theoretical obstacles must be addressed before it can be put into practice. We recommend developing pilot projects that are specifically designed to address the challenges of ecosystem service certification. Based on the relative lack of success of timber certification in the tropics, building on the existing certification framework might not be the best way forward. Creative solutions will be required to address these challenges.

1 Background

Payments for ecosystem services are considered an effective way of funding the costs of forest conservation, by offsetting the opportunity costs of forest development. If such payment systems could be made effective they could become a key element in global strategies for mainstreaming forest biodiversity conservation and maintaining essential support services from forests. This would contribute to meeting Millennium Development Goal 7, on environmental sustainability, as well as the Bali Roadmap of the UN Framework Convention on Climate Change (UNFCCC) on establishing verifiable mechanisms to reduce emissions from deforestation and forest degradation (REDD).

According to the Millennium Ecosystem Assessment, more than 60% of the world's ecosystem services are either degraded or used unsustainably (Millennium Ecosystem Assessment 2005). The Stern Report (Stern 2007) also highlighted the detrimental effect of deforestation on climate change. The value of forest ecosystem functions is extensive, in terms of both the environment and income generation. Realising this income potential requires the development of viable markets, bringing buyers and sellers together, and organising governance systems that ensure that revenues are allocated in such a way that they bolster the sustainability of ecosystem services. Established markets for these services remain small and scaling them up will require a significant increase in both demand and supply for commoditised ecosystem services.

Many pilot activities have sought to establish trading systems between sellers and buyers of ecosystem services, including watershed services, carbon sequestration and biodiversity. Success has varied considerably. One of the key challenges in marketing ecosystem services is measuring those services and translating them into values. Without clear guidelines on quantifying ecosystem services it will be very difficult to commoditise them and scale up their markets. Certification is one approach to developing these guidelines, by determining what constitutes a sustainably managed ecosystem service.

The purpose of this review is to identify and analyse constraints to certification of ecosystem services from forests, in terms of measurement, governance and adoption. The assessment is based on available literature and identifies gaps in existing scientific research.

2 Introduction

2.1 What are ecosystem goods and services

Humankind benefits from a multitude of resources and processes that are supplied by natural ecosystems. These benefits include products like clean drinking water, processes such as the decomposition of wastes, or spiritual values. Although recognition of the value of nature to society has a long history (Krutilla 1967; Westman 1977; Daily 1997), the significance of ecosystem services to humanity was strongly boosted by the United Nations 2004 Millennium Ecosystem Assessment, a four-year study involving more than 1,300 scientists worldwide (Millennium Ecosystem Assessment 2005). This assessment grouped ecosystem services into four broad categories: 1) provisioning, such as the production of food and water; 2) regulating, such as the control of climate and disease; 3) supporting, such as nutrient cycles and crop pollination; and 4) cultural, such as spiritual and recreational benefits.

The monetary value of global services of ecological systems has been estimated at US$16–54 trillion per year (Costanza *et al.* 1997), although others have argued that we are a long way off from assessing the economic consequences of losing nature (Balmford *et al.* 2011). Such global estimates which are based on broad extrapolations have their critics. The approach assumes that every hectare of a given habitat type is of equal value—regardless of its quality, rarity, spatial configuration, size, proximity to population centres, or the prevailing social practices and values (Nelson *et al.* 2009). Nevertheless, the resulting estimates provide some idea of the order of magnitude in which ecosystem services are counted. These figures can be compared to a recent analysis which estimated that by the year 2030, markets for biodiversity conservation could benefit 10–15 million low-income households in developing countries, carbon markets 25–50 million, markets for watershed protection 80–100 million, and markets for landscape beauty and recreation could benefit 5–8 million low-income households (Milder *et al.* 2010). The overall conclusion that ecosystems can provide very large benefits to humanity is clear. The question is, however, as posed by Krutilla (1967), 'if a genuine value for retaining an option [to use an environmental service] ... exists, why has not a market developed? ' Krutilla's general assessment that the demand for environmental services was often less than the demand for alternative uses of those lands and waters, is as true today as it was over 40 years ago. The reasons why require examination.

Ecosystem services are often lumped together but need to be differentiated from ecosystem goods. Ecosystem services are the processes that nature provides: purification of water, carbon sequestration, mitigation of floods, or pollination of crop plants by insects and other animals. Ecosystem goods are the tangible outputs from some of these processes—clean water, for example. Grouping services and goods together, as is done by the Millennium Ecosystem Assessment (2005), has the advantage of brevity and simplicity, but tends to obscure the distinction between the functional nature of ecosystem services and the concrete nature of ecosystem goods (Brown *et al.* 2007). The distinction between goods and services is important for certification. Many goods are certified without any reference to the ecosystems from where they derive. For example, tap water in most wealthy countries is generally tested and certified to be of a certain quality at household level. This does not, however, say anything about where the water has come from. In this review we specifically deal with certification of the processes and co-benefits related to good forest management, which may or may not translate into certification of the goods derived from those processes.

Ecosystem goods and services are listed in Table 1, leaving out ecosystem goods such as fossil fuels and minerals, which can only be renewed over very long time spans and are thus outside the scope of this review. Somewhere between goods and services are the cultural and spiritual values of ecosystems. They appear to be neither a good nor a service, as defined above, but are of obvious importance in how we regard or value ecological systems. Four types of ecosystem services appear of particular relevance for forested ecosystems—carbon sequestration, biodiversity protection, watershed protection or hydrological services, and cultural and spiritual heritage, including the aesthetics of forests.

Table 1. Ecosystem goods and services

Ecosystem goods
• Wildlife and fish (food, furs)
• Plants (food, fibre, fuel, medicines)
• Water
• Air (oxygen, carbon)
• Soils
Ecosystem services
• Purification of water
• Carbon sequestration
• Translocation of nutrients
• Maintenance and renewal of soil and soil fertility
• Pollination of crops and natural vegetation
• Dispersal of seeds
• Maintenance of regional precipitation patterns
• Erosion control
• Maintenance of habitats for plants and animals
• Control of pests affecting plants or animals
• Protection from the sun's harmful UV rays
• Contributions to stabilisation of climate
• Moderation of temperature extremes and the force of winds and waves
• Mitigation of floods and droughts
Human-centred values and services
• Spiritual values
• Recreations
• Aesthetics (e.g. landscape beauty)
• Education opportunities

Source: Based on Brown *et al.* (2007)

2.2 The economics of ecosystem services

Ecosystem services are often discussed in the context of externalities. These are defined as third-party (or spillover) effects arising from the production and/or consumption of goods and services for which no appropriate compensation is paid. Externalities create a divergence between the private and social costs of production: Social costs = private costs + externalities. Externalities can be both negative and positive (= external benefit). The market-driven approach to correcting externalities is to 'internalise' third-party costs and benefits, for example, by requiring a polluter to repair any damage caused, or that the third-party compensates the land user for the costs of avoiding the damage in the first place (payments for ecosystem services, or PES). Some ecosystem services are fully internalised by the land user, such as the on-farm protection of soil fertility. Many services, however, are positive externalities, or a potential negative externality that is being avoided. These externalities can be private (e.g. a single downstream water user affected by the land user's sedimentation of the watercourse), club goods (e.g. a limited downstream community receiving the same benefit) or public in nature (e.g. the global community benefiting from mitigated global warming through tree planting).

The characteristic that differentiates PES from previous paradigms or approaches is that the payments are conditional on changes in land use by the service provider. They are similar to taxes and subsidies where the tax or subsidy depends on outputs such as pollution or environmental improvement. A useful, and increasingly widely accepted, five-clause definition is provided by Wunder (2005), who proposed that a payment for environmental services is:

1. a voluntary transaction in which
2. a well-defined environmental service (ES) (or a land use likely to secure that service)
3. is being purchased by at least one ES buyer
4. from at least one ES provider
5. if, and only if, the ES provider ensures the supply of the ES (i.e. there is conditionality).

The voluntary nature of the transaction distinguishes PES from the conventional command-and-control approach of many governments. This presupposes that potential ecosystem services providers have real land-use choices, requiring a fair and transparent system of land tenure and rights. For the ecosystem service to be 'well-defined' it must be measurable: such as in *tonnes* of carbon sequestered, or *turbidity levels* in water; or, alternatively, in the area of lands where use is restricted in order to provide specific services (e.g. 'forest conservation providing clean water'). Structuring the arrangement as a relationship between a buyer and an ecosystem service seller clearly defines the principles and counters the tendency for third parties to appropriate the financial benefits. The conditionality criterion serves to separate PES from many other incentive-based resource management approaches. In its simplest form, it means that the payment will only be made when the providers of the service implement the changes producing ecosystem services and ensure that they are continuously provided. For the purpose of this review the definition of Wunder (2005) will be used, as it fulfils conditions required for the certification of ecosystem services.

2.3 Markets for ecosystem services

Early successes in developing PES schemes have focused on carbon and watershed services, although a few biodiversity schemes exist, as do some related to landscape beauty. Recent interviews with people active in various PES sectors showed that the overwhelming majority believe that in the short- to medium-term, demand for forest- and agriculture-based carbon credits will vastly exceed demand for other PES systems, although demand for these, notably PES for water and biodiversity conservation, will continue to grow (Forest Trends 2008). The global forest carbon market in 2009 was worth about US$150 million, covering 2.1 million hectares of various forest carbon sequestration or avoided emission activities in 226 project areas (Hamilton *et al.* 2010). No such estimate could be found for the global value of other forest-related PES markets, but the market for fresh water services is likely to be as large if not larger than the one for carbon. The terrestrial renewable freshwater supply has been estimated at 110 300 km^3/year, of which humans appropriate some 23% (Postel *et al.* 1996). Forested watersheds play a major role in the regulation of the runoff and evapotranspiration that provide these services. Recognising the potential value of ecosystem services and creating real markets in which these services are traded are two very different things. Developing a forest ecosystem services market differs significantly from the development of any other new market in that ecosystem services which are currently free must be commoditised. In this political process, the rights and responsibilities of stakeholders must be established and new rules and regulatory bodies set up (Sun and Liqiao 2006).

A major challenge in developing markets for ecosystem services is determining tradable values. It is relatively straightforward to measure the quantity and quality of commodities such as wheat, oil, or coal, but this becomes much harder when the related payments target the maintenance of systems that produce the commodities, e.g. forests that sequester carbon, retain water, or harbour a diverse species complex. Ecosystem services are defined through the holistic measures of ecology rather than the uncontroversial measures of weight, volume or time (Robertson 2006). What is the 'unit' of an ecosystem service that would allow translation into cost per unit price, as in US$ per tonne of carbon? Even in cases where it is relatively straightforward to express the impact of a service, for example, the additional fruit harvest because of proximity to natural pollinators, it is still very hard to link that to a unit of an ecosystem. Cognitive problems also arise because of the functional opaqueness of environmental assets; therefore individuals cannot make comparisons across scales and have difficulty converting environmental goods and services into monetised units for comparison with other goods (Gren *et al.* 1994; Vatn and Bromley 1994). Many different approaches now exist or are being developed for measuring ecosystem services, with most attention going to measurement of carbon sequestration and emission in forests. Significant problems remain, however, due in part to the complexity of ecosystems (Kontogianni *et al.* 2010).

Critical to the success of developing working markets for ecosystem services are the transaction costs. Transaction costs can be defined as ' all those costs associated with buying and selling in a market' (Bannock *et al.* 1991). In the context of ecosystem services these include: agreeing on the nature, extent and timing of the payments or in-kind transfers; and drawing up contracts and monitoring the outcomes of the agreement on all parties (Bond and Mayers 2010). The level of transaction costs can 'make or break the market' (Landell-Mills and Porras 2002). For example, there is growing evidence that transaction costs within PES mechanisms might be higher than intuitively expected by PES developers possibly contributing to high frequency of project failure (Bond and Mayers 2010). Local income from ecosystem services should not just match the opportunity costs of forest development, but significantly exceed them to convince local stakeholders to refrain from business as usual (Engel and Palmer 2006, 2008).

2.4 Certification of ecosystem services

The complexity of measuring the quality and quantity of ecosystem services and the related development of payment systems requires new standards that are commonly agreed by various market participants and governments, and implementation requires external oversight to assure credibility. Certification of the management of forests and their services is one possible approach to ensure that standards in PES systems are maintained, and that payments are transparently and accountably linked to the quality of forest ecosystem management.

Forest certification is a system for identifying well-managed forests, requiring the maintenance of ecological, economic, and social components, as well as associated ecosystem services. Products from certified forest land can, through chain-of-custody certification, move into production streams and in the end receive labelling that allows buyers to know the product came from a certified, well-managed forest (Hansen *et al.* undated). Fully implemented, certification is a market-based mechanism to reward superior forest management.

To determine which ecosystem services could potentially be certified, one has to look at the underlying values and their metrics, as well as the demand and supply side. For instance, if there is just one service user and one supplier, then certification makes little sense. It would add significant transaction costs to what is effectively a simple business deal, where a buyer and seller agree on a price for a given quantity of services, and this settles the deal. Additional transparency through certification would have few if any added benefits, because no broader market is interested or involved in the deal, unless the buyer has to demonstrate ethical behaviour to third parties (e.g. NGOs, governments). On the other hand, if more of a 'market type' exists, with multiple agents to choose to do business with, then the case for certification is clearer—especially if supply is not transparent, and if buyers are small or with insufficient resources to check ecosystem service provision closely on their own.

This review will systematically address the various aspects of successful certification of ecosystem services. It will first look at certification in general and what makes it work. Next, it will review the various ecosystems goods and services. These will be discussed with regard to established certification schemes, which should provide insight into the barriers to certification of ecosystem services. These constraints will be analysed in terms of the role of scale, the challenges of monitoring and verification, and issues of tenure, jurisdiction, and regulation. The issues will be reviewed and a set of recommendations provided to maximise the chances of developing successful certification systems for ecosystem services.

3 Methods

3.1 Literature review

This review is based on an analysis of the available literature. Electronic literature databases, such as Web of Science, Current Contents, and Google Scholar were searched, using simple search terms such as 'ecosystem services', 'certification', 'REDD', or combinations such as 'watershed AND services AND certification'. The resulting citations were traced to the original publications, and these were studied in as much detail as possible, given the limited period of this review.

3.2 Specialist input

In addition to the literature review, discussions were held via email correspondence with specialists in the field working at CIFOR, the Forest Stewardship Council (FSC), and several academic institutions with an interest in ecosystem services.

Limitations. The fields of ecosystems services and certification are large and there is a vast amount of published and unpublished literature. By necessity this review cannot claim to be complete and having addressed all relevant documents. The information and insights are therefore based on a mostly random subsample of papers and reports available in the published and grey literature, or whatever information could be traced and accessed within the time available. In terms of the objectivity of the review, the question is whether the selection of information sources or their interpretation was biased.

An obvious potential source of bias is the lead author himself. The focus and thinking within this review has likely been influenced by his experience working as an ecologist in the Asian tropics. This may mean, for example, that approaches that have worked well in temperate forest areas have been given less attention because they were assessed as unlikely to work in the tropics. Also, this background has probably biased the review towards the ecological and management aspects of ecosystem service certification, rather than, for example, the economic and market aspects—although these are also discussed. At a later stage in the writing process, input from co-authors with much broader geographic experience allowed for compensation of geographic biases.

Another potential source of bias is that the review accessed some 40 project reports from organisations that had been involved in the development of payment for ecosystem services projects. These organisations may not have provided entirely objective reviews of their own projects, since organisations tend to give positive assessments of project outcomes in the light of funding opportunities or stakeholder relationships. Under-reporting of failure in conservation projects is a well-known phenomenon (Ferraro and Pattanayak 2006; Field *et al.* 2007).

4 Conceptual model for certification

Certification is a process of controlling particular aspects of a system to provide some guarantee to outsiders that the systems complies to an agreed set of rules. The principles and criteria of certification have been likened to a filter (Meidinger *et al.* 2003). You take a system, pour it through a filter, check inside, and if nothing sticks, it is okay. The filter is most often implemented by an independent party. Residues in the filter indicate noncompliance and require action. Certification does not generally refer to the legal aspects of a system, which is referred to as licensure. Usually, licensure is administered by a governmental entity for public protection purposes and certification by a professional association. However, they are similar in that they both require the demonstration of a certain level of performance of a system (or person or organisation) according to a set of rules and regulations, or principles and criteria. Also, some certification systems require the adherence to legislation in their principles or criteria. For example, the Forest Stewardship Council (FSC) Principle 1 requires 'compliance with all applicable laws and international treaties'. Thus, even though certification does not administer licensure, it can demand that legal requirements are fulfilled.

This review assesses whether the certification of ecosystem services could work. For this we need to know what makes certification work in general, and what the common pitfalls are. To establish a conceptual working model for this review, a logical analysis is conducted that first looks at the general principles of certification, then the role of markets, the role of scale, the role of governance, and the role of monitoring. Next, an overview of existing certification schemes will provide some insight into gaps between the systems that are required to implement ecosystem service certification and existing certification systems for forests. Once the characteristics of successful certification have been identified, individual ecosystem services will be reviewed in the light of these characteristics, which should provide some idea of their suitability for becoming certified commodities. In the discussion, the requirements for successfully certifying ecosystem services will be juxtaposed to existing certification schemes resulting in recommendations for how to best proceed.

4.1 What makes or breaks forest certification?

Forest certification assumes that the people responsible for a forest are taking care of it properly. This implies that: 1) we understand what it means to take care of a forest properly; and that 2) a person trusted by external parties and who understands proper forest management 3) visits the forest and assesses the work of the people who manage it and 4) certifies to others that things are being done correctly (Meidinger *et al.* 2003). Even though certification aims to be objective through clearly defined principles and criteria, the individual's interpretation of standards gives it a subjective aspect. In addition to the variation of subjective interpretation, evaluation of the forest management depends on certification standards.

Standards vary along a gradient from desirability on the certifiers' side to practical feasibility on the forest managers' side.

A final requirement for certification is the presence of a market for certified products, with people or institutions willing to pay a price premium, for example, to cover the transaction costs of ensuring that products have come from a forest area managed according to the minimum requirements of the certification standard.

The aims of certification are often quite broad, after all, they concern social value-driven problems which somehow need to be addressed by market-driven solutions (Vogt *et al.* 2000). Society is concerned with a range of social and environmental values in forests, and these are not always the same as the values of local resource users or stakeholders. Certification therefore addresses a fine balance between use and conservation. In general it does this by:

- controlling resource management techniques
- addressing factors that could undermine sustainable use, such as poverty
- creating a system that assures society that environmental and social concerns and values have been addressed
- managing resources holistically so that healthy environments are maintained
- balancing the need to extract resources from the environment while maintaining sustainable ecosystems (Vogt *et al.* 2000).

A key issue in this list is the concept of sustainability. Scientists have hardly begun to understand the complex functioning of forests, especially those in the relatively poorly studied tropics, with millions of interactions between species and their abiotic environments determining the overall dynamics of an ecosystem. To what extent can humans interact with such systems or extract resources from them without violating their long-term viability? There are no clear answers to that, leaving it open to society, or the certification schemes which represent society in this, to determine the terms under which a system is judged to be managed sustainably. Ultimately, considering the above-mentioned complexity of forest ecosystems, this is an impossible task, but that doesn't mean that with best guesses and common sense, it isn't possible to develop guidelines for what best approaches sustainable management.

Certification is not solely fact-driven but also value-driven. It requires systems that balance a variety of societal expectations regarding sustainable forest management with the economic interests of forest owners and those willing to pay for certified products. It is therefore no surprise that there are many different sets of criteria and indicators of what constitutes sustainable forest management (e.g. those developed by the Sustainable Forestry Initiative, CIFOR, Smartwood (Rainforest Alliance), Scientific Certification Systems (SCS), Silva Forest Foundations, to name just a few). What matters for those seeking sustainable management of forests is which system has the biggest impact on trade in forest products and services, while providing a guarantee that the guidelines for sustainable management of forests and their services have been followed (note our definition of sustainability in the Glossary). For this a certification system needs to be accepted by forest owners and producers, as well as members of society who are concerned about sustainable forest management, with wholesale, retail and end-user markets willing to pay for the certified goods (Figure 1).

4.2 The role of markets in certification

Many markets for ecosystem services and goods operate across the globe. Some are large and well-coordinated such as the European Climate Exchange, and others are relatively small, experimental and localised in their scope. Not only are there different types of markets for different ecosystem services and goods, there are also many different mechanisms through which these markets operate. These include cap and trade markets, compliance driven markets, government ecosystem service payments, voluntary private ecosystem service payments, taxes and other regulatory measures, and certification. Each mechanism has different rules and regulations governing how they work and who can participate as both buyers and sellers of ecosystem services (Enright 2010).

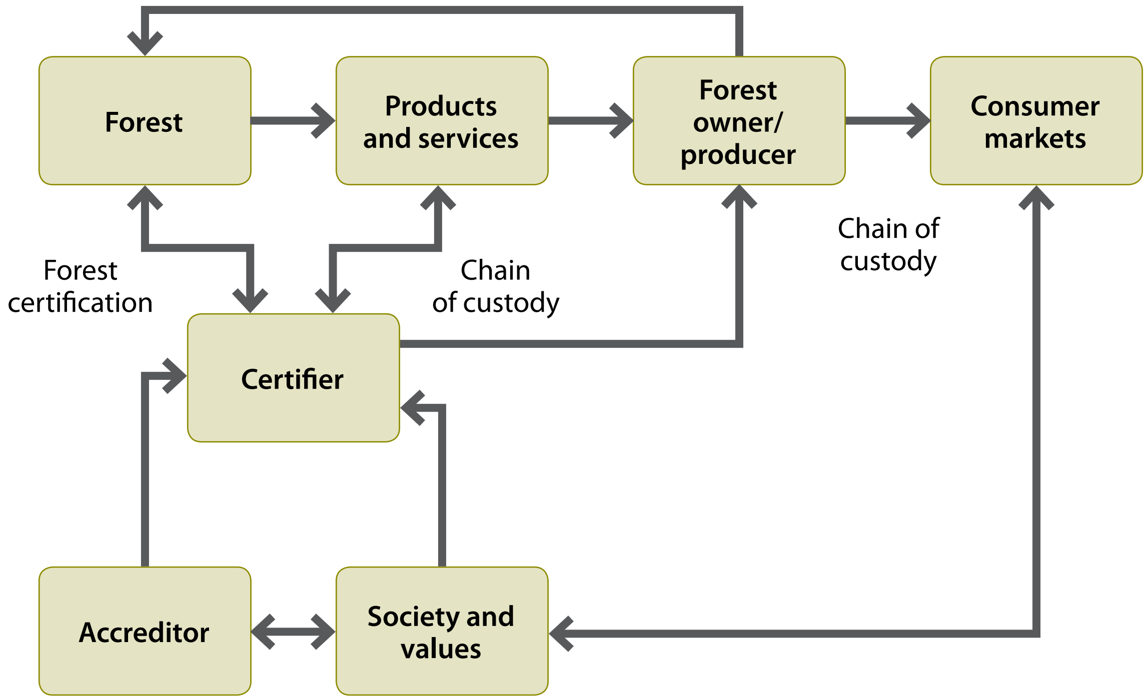

Figure 1. Components of certification

Note: Governments strongly influence the components in this diagram.

Source: Adapted from Sprang (2001)

As certification is a private sector, market-based tool it is important to assess the role of markets in the certification of forest ecosystem services and goods. The three most important market benefits of forest certification are potential market access, improved public image and price premiums (Chen *et al.* 2010). Interestingly though, a recent study in Brazil (Araujo *et al.* 2009) suggested that market incentives did not play an important role in the adoption of forest certification, and that the non-financial benefits of certification were much more important to producers. This included increased public confidence, clarification of land rights, improvement of forest management and practices, improvement of management systems and performance, self-discovery of non-conformance, and better public, landowner, and supplier communication. Reviews in the United States of America similarly found that direct financial incentives were less important for producers in deciding for or against taking up certification than non-financial ones (Overdevest and Rickenbach 2006; Tikina *et al.* 2008). Although forest certification has achieved major progress by enabling certified forest products to penetrate some environmentally sensitive market niches and by maintaining and enhancing the public image of forestry companies, the price premium has proved difficult to realise, especially for commodity products such as pulp and structural lumber (Klooster 2006; Chen *et al.* 2010).High value products, such as tropical hard woods appear to do better in obtaining a premium price (Nebel *et al.* 2005; Kollert and Lagan 2007), but generally the non-financial aspects of forest certification for timber appear to outweigh the direct financial ones. This is an important consideration when assessing the constraints and barriers to ecosystem services certification. To what extent are these constraints driven by financial aspects and to what extent by non-financial aspects? Are financial considerations for timber and fibre different than for other ecosystem goods and services and what would be their characteristics?

One of the possible differences between timber-based certification and certification of other ecosystem services is that timber-based certification tends to involve clearly defined relationships between the resource (the forest and its products), the land owner (e.g. the concessionaire), local stakeholders (e.g. communities and government), external stakeholders (e.g. international NGOs and other watch dogs), and the buyers of certified timber. Land owners apparently care more about the positive impact of certification on management effectiveness, relationships with local stakeholders, land tenure issues, and public image, than they do about selling products at a premium price. This was also found for other ecosystem service goods, such as wild-grown coffee in Uganda, for which the indirect financial benefits to the traders related to the story of certification was likely to far exceed actual values of certified products (Lilieholm and Weatherly 2010), suggesting a potential scam. For less tangible ecosystem services, such as water provision or carbon sequestration, the relationships between resource, resource owner, local stakeholders, and external stakeholders and markets is less clear. Who owns and has the right to sell the services, and how could external factors such as public opinion and stakeholder relationships, influence this? For these ecosystem services market access and other financial considerations may have a more important role in the take up of certification than it has for timber.

The different incentives for certification require careful consideration because they play an important role in deciding what kind of certification system would best suit non-timber ecosystem services and goods. If financial considerations such as market access and price premiums are more important, this might require certification systems that focus more on quantification of the services and underlying social and environmental values. However, if non-financial values are more important, more holistic certification systems are required that focus on broader issues of the social and environmental sustainability of the ecosystems from which the services are derived.

4.3 Certification at small and large scales

Forest certification for natural forests and plantations happens at scales varying by several orders of magnitude, from a few hundred hectares to more than a million, but in general the focus is on large rather than small areas (e.g. Nebel *et al.* 2005; Wyatt and Bourgoin 2010). The scale also varies according to the certification scheme (Schlyter *et al.* 2009), with FSC generally concerning larger forest areas (134 340 000 ha certified over 1014 forest management units = average 132 485 ha/unit), and PEFC on smaller areas (223 000 000 ha over 7143 forest management units = average 31 219 ha/unit). A recent review found that forest certification schemes following industry standards, like the Sustainable Forest Initiative (SFI) in the United States and the PEFC standard have developed more organically around the significant participation of smallholders in timber supply—as outgrowers and as natural forest managers (Butterfield *et al.* 2005).

The bias towards large management units might exist because, as pointed out in the previous section, financial incentives appear to be less important drivers of certification than non-financial ones, and non-financial incentives may be more relevant to large management units, with high public visibility and global distribution networks. Furthermore, the costs of certification and monitoring and forestry management in general, are lower per unit of timber produced and sold for large producers than for small producers (Grieg-Gran *et al.* 2005). For those smallholders in the higher value timber markets—hardwoods and tropical woods for higher wood product grades and finished products—certification is attractive if it can help them to access niche markets that recognise their products' quality and, in the case of timber from natural forests, the multiple social and environmental values of sustainable forest management (Butterfield *et al.* 2005). Such niche markets also exist for other ecosystem goods, such as forest honey or other small-scale non-timber forest products. For ecosystem services such as carbon sequestration and watershed protection which are unlikely to be traded in niche markets, the transaction and other certification costs might also drive project development towards larger scale areas. The issue of scale in relation to costs is therefore important in the development of certification systems for different types of ecosystem goods and services. If costs outweigh benefits for small-scale land owners, many attempted projects will fail.

To reduce the unit costs, group certification has been suggested, in which groups of land owners obtain certificates for cooperatively managed forest landscapes to spread the costs of evaluations and audits (Butterfield *et al.* 2005; Ghazoul *et al.* 2009; Ghazoul 2010). The FSC has also developed 'Small and Low Intensity Managed Forest'standards (SLIMFs) to simplify the certification process for smallholders and communities whose scale or frequency of harvest puts less pressure on the environment. Certification of SLIMFs is, however, mostly restricted to wealthier countries (Humphries and Kainer 2006). Furthermore, the Indonesian Ecolabelling Institute (LEI) has developed a community-based forest certification procedure (*Pengelolaan Hutan Berbasis Masyarakat Lestari*) specifically to promote community-based forest management (Maryudi 2009). However, these alternative schemes have yet to significantly lower the expense of certification in poor countries (Butterfield *et al.* 2005).

4.4 The role of governance

A useful definition of governance is 'a set of regulations and rules of conduct that, without necessarily emanating from an official authority, define practices, assign roles and guide interaction to address collective problems in an increasingly interdependent world marked by the proliferation of networks of stakeholders' (Rosenau and Czempiek 1992). Forest certification has been designed as a voluntary private-sector instrument that can bypass weaknesses in public-sector governance (Purbawiyatna and Simula 2008). It has been argued that forest certification is leading to the privatisation of forest governance, which traditionally has been in the hands of centralised state governments (Agrawal *et al.* 2008; Guéneau and Tozzi 2008). For the successful certification of ecosystem services it will be important to know where along the spectrum from centralised state governance to localised private governance the various ecosystem services and goods will be managed. It is possible that, ecosystem services such as carbon sequestration and watershed protection, which potentially have a large global demand, will initially be dominated by state governance. The role of privatised versus state governance will likely also be determined by the scale of projects, with more extensive projects at landscape level requiring determination and enforcement of land tenure and management rights by the state. Börner *et al.* (2010) argued that command-and-control measures from state governance are needed to secure effective rights of exclusion, which land stewards essentially need in order to become reliable service providers. Such systems would go against the voluntary nature of payments for ecosystem services (PES) as earlier defined.

Another major challenge to the new private accountability in forest governance is the tough competition among various forest certification systems (Chan and Pattberg 2008). More than 30 different forest certification standards now exist at national, regional and global levels, giving forest owners a choice of regulatory systems. This range of competing standards may, however, undermine the concept of sustainability certification, since consumers rarely have the knowledge to assess various schemes (Chan and Pattberg 2008). The critical attitude of many environmental NGOs towards certain certification standards exemplifies the growing concern about maintaining standards that strive for the original sustainability goals of certification.

The experiences from timber and pulp certification hold important lessons for the certification of ecosystem services and goods. Each type of service and good will require careful consideration of the role of governance in developing and implementing guidelines for management of the services and goods and the forest ecosystems in which they occur. To what extent are governments needed for command-and-control and access and ownership of forests and their services? How would government management affect the voluntary nature of PES schemes and their certification? And to what extent do certification schemes fill the gaps in implementation of forest management caused by weak state governance (Visseren-Hamakers and Glasbergen 2007)?

4.5 Monitoring in certification

Demand for increased accountability and transparency in environmental management has resulted in a general increase of monitoring and evaluation programmes. Most environmental NGOs will include at least the semblance of indicators, milestones and performance targets in their programmes. The scientific rigour of such programmes, however, could be much improved (Pullin *et al.* 2004; Sutherland *et al.* 2004; Ferraro and Pattanayak 2006). Constraints on the implementation of rigorous monitoring programmes include the demand on financial and human resources, and the significant technical challenges of proving statistically robust impacts compared to business-as-usual scenarios (Sheil *et al.* 2004).

Monitoring in forest certification and sustainable forest management faces similar challenges (Hickey *et al.* 2007). Monitoring is, of course, an integral part of the principles and criteria of certification itself, i.e. forest owners are required to monitor their own management and the impact this has on social and environmental values. In certification schemes in the United States the monitoring aspect of certification is among those that most frequently require improvement before forests can be certified (Newsom *et al.* 2006). At a broader level, monitoring of the actual impact that certification has on the values and services it aims to protect or sustainably manage, is a lot more challenging. Despite over 15 years of such certification, involving 300 million ha of forest globally, there is little understanding of whether it achieves its targets of sustainable forest management. A literature study on the impacts of certification on biodiversity, for example, was ambiguous in its conclusions (van Kuijk *et al.* 2009). The study revealed the difficulty of providing a clear answer to the question of environmental sustainability. It also found that in most certified forests the data needed to assess the effects of management on biodiversity are not being systematically collected, while data from non-certified forests, which are needed for comparison, are even harder to find. The take home message from this is that practically feasible certification of ecosystem services will require monitoring systems that can be adjusted to specific needs and resources. A level of flexibility may be required in monitoring which is unlike the rather prescriptive requirements of existing certification schemes (McDonald-Madden *et al.* 2010).

The van Kuijk study (2009) study above also highlights the discrepancy between public perception of certification as a guarantee for sustainability, and the actual criteria of a certification standard. Certification standards are ‘social contracts’ that entail a compromise between sometimes incompatible interests, or at least a trade off between what is desirable and practically feasible in forest management. Such a grey area makes it hard to determine whether certification ‘works’ or not. For the purpose of determining whether certification of ecosystem services has practical feasibility, however, there needs to be some measure by which to determine success.

5 Overview of ecosystem services and goods

5.1 Carbon sequestration

Approximately 12–20% of global greenhouse gas emissions are caused by land use change and, in particular, the destruction of tropical forests (Metz *et al.* 2007; van der Werf *et al.* 2009). Reducing land-use change and forest degradation has been proposed as a cost-effective way of slowing carbon emissions compared to other mitigation strategies such as curbing emissions from power stations. Decisions taken at the Conference of the Parties to the UNFCCC in Bali, 2007 opened the possibility for reduced emissions from deforestation and forest degradation (REDD) payments to become part of the post-Kyoto framework agreement, and for short-term pilot projects. Consequently, the governments of many industrialised countries are announcing significant new funds to tackle climate change. The Government of Norway, for example, through its International Climate and Forest Initiative, will allocate up to 3 billion krone a year (≈US$500 million/year) between 2009 and 2012 to mitigate greenhouse gases produced by land-use change (Bond *et al.* 2009), with US$1 billion committed to Indonesia alone over a 3–4 year period (Government of the Kingdom of Norway 2010).

Among all the other non-timber ecosystem services and goods, certification of carbon sequestration appears the most likely one to succeed. Either through mechanisms of afforestation/reforestation under the Clean Development Mechanism (CDM), REDD, or REDD+—which goes beyond REDD and includes conservation, sustainable management of forests and enhancement of forest carbon stocks—there appear to be some of the preconditions and advantages for certification that the other services do not have. There are potential markets with multiple agents. Carbon is a measurable and not just a perceptional commodity. Carbon can be sequestered, stored, quantified and compared among many different places where carbon is either produced or stored. Carbon thus fulfils many criteria of commoditisation. The science to measure carbon is also much more mature and less complex than for watershed services or other even less tangible ecosystem services.

The suitability of carbon for certification is reflected in the rapidly increasing number of forest carbon projects that have included some form of certification. For example, the over the counter (OTC) voluntary carbon market exhibits an intensifying use of standards, particularly those that emphasise the co-benefits of forest carbon projects and third-party verification (Hamilton *et al.* 2010). Hamilton *et al.*'s (2010) analysis indicated that 86% of all OTC forest carbon offsets originated from projects involving an internal or third-party standard. Certification to third-party standards increased significantly from a mere 15% of offsets in 2002 to 96% in the first half of 2009, and accounted for 70% of all OTC offsets transacted over time.

A range of standards for forest carbon offsets are presently in use. These include the Clean Development Mechanism (CDM), the American Carbon Registry (ACR) Forest Project Standard,

Table 3. Forest management and carbon standards and how they relate to each other

<table>
<tr><th>Sustainable forest management standards</th><th>REDD+ project/programme design standards</th><th>GHG accounting standards</th></tr>
<tr><td colspan="2">Forest Stewardship Council (FSC)</td><td>ISO 14064:2006 Parts 2 and 3</td></tr>
<tr><td colspan="2">Programme for the Endorsement of Forest Certification (PEFC)</td><td>Voluntary Carbon Standard (VCS)</td></tr>
<tr><td></td><td>SOCIALCARBON Standard</td><td></td></tr>
<tr><td colspan="2">Climate, Community and Biodiversity Alliance (CCBA) REDD+ Social and Enronmental (S&E) Standards</td><td></td></tr>
<tr><td colspan="2">Climate, Community and Biodiversity (CCB) Standards</td><td></td></tr>
<tr><td colspan="3">CarbonFix Standard (CFS)</td></tr>
<tr><td colspan="3">Global Conservation Standard (GCS)</td></tr>
<tr><td colspan="3">Plan Vivo Standards</td></tr>
</table>

Source: Merger and Williams (2008)

the CarbonFix Standard (CFS), the Climate Action Reserve (CAR), the Climate, Community, and Biodiversity Standards (CCBS), the Greenhouse Friendly initiative in Australia, ISO 14064, which is a carbon project accounting standard developed by the International Organization for Standardization (ISO), Plan Vivo Standards, Société Générale de Surveillance (SGS), Carbon Offset Verification Standard, Social Carbon, and the Voluntary Carbon Standard (VCS). The latest Version 3.0 of CFS, which was released in August 2009, includes an improved approach to combined certification with the Climate, Community and Biodiversity Alliance (CCBA) and FSC (Hamilton *et al.* 2010). A recent review showed how some of these standards relate to sustainable forest management, REDD+, and greenhouse gas accounting (GHG) (Table 3). This proliferation of standards and to some extent associated certification systems mirrors the situation in the timber and pulp certification industry.

Hamilton *et al.* (2010) report that these standards broadly fall into two categories: those that focus on the quality of measuring and monitoring carbon, and those that focus on qualities beyond carbon (the 'co-benefits'). There is increasing interest among carbon buyers in these social and environmental co-benefits, although qualifying and quantifying these benefits is complex. According to a recent survey among potential buyers of credits (Ecosecurities 2009), the most desirable carbon standards were the CDM and the VCS. Credits generated from projects that are only registered by the CCBA standard are less desirable. However, a dual certification of CCBA combined with either CDM or VCS can provide carbon buyers more certainty around the co-benefits which make forest carbon projects more interesting to a certain segment of carbon credit buyers (De Gryze and Durschinger 2009).

One counter-intuitive result in the review by Ecosecurities (2009) is that certification under both the CCB Standard and another recognised carbon standard (VCS or CDM)was rated as less desirable by carbon buyers than a certification under the other recognised carbon standard alone (46% versus 60%). (Note that the CCB Standards do not issue emissions reductions certificates.) This contradicts the stated willingness of many buyers to pay a price premium for this combination and may be due to a lack of knowledge about the CCB Standards and the possibility and benefit of combining them with other carbon standards.

Finally, the Ecosecurities survey gave some insight into the willingness of carbon buyers to pay a premium price for co-benefits to carbon offsets. About a third of the participants (30%) stated they would pay premiums of US$4 and more per offset that is also CCB certified. High premiums generally corresponded to buyers who were willing to pay higher prices for the offsets in the first place. A majority of respondents (77%) are willing to pay a premium of at least US$1 per offset for CCB certified projects, and almost all of the carbon companies (89%) are willing to pay a premium of at least US$1 per tonne, though few are willing to pay premiums greater than US$3 per tonne (Ecosecurities 2009).

As previously mentioned, financial incentives might not necessarily be the major driver behind certification for forest ecosystem services, but these data give at least some indication of how much carbon buyers would be willing to pay to ensure environmental and social sustainability in a project. Empirical work suggests that the implementation and transaction costs of REDD are about US$1 per tonne of CO_2 (Olsen and Bishop 2009), suggesting that the premium price that buyers are willing to pay could compensate for the additional costs of protecting social, cultural and environmental values. As expected, these cost estimates vary considerably, with costs increasing with the remoteness of an area, the level of political opposition, and the need for international expertise (Olsen and Bishop 2009).

The above data suggest that there are good opportunities for developing certification systems for carbon projects, although there is strong competition between different standards. A recent report by Forest Trends (2008) indicated that this is an issue of concern. Several people interviewed said that the lack of a single, credible standard in the voluntary markets and the associated perceived uncertainties about forest-carbon credits have undermined demand for these credits.

Another area of concern raised by interviewees in the Forest Trends report is whether some of the new standards, notably the VCS and CCBA, will be able to deliver the large volumes required by major corporations seeking to offset their carbon footprint, and institutional buyers seeking to sell carbon credits to them. They noted that the likes of the Chicago Climate Exchange, which has the potential to provide large volumes of carbon at relatively low prices, particularly associated with large-scale plantation afforestation or reforestation initiatives, are likely to dominate future forest-carbon credit sales. On the other hand, rapid growth in demand for chain-of-custody certification in the forest sector is likely to drive the demand for sustainable forest management certification, which, in turn, should lead to increased demand for forest-carbon offsets and associated certification. Combined payment for ecosystem services (PES) and forest certification is an obvious option to help improve the profitability of certified forests (Forest Trends 2008). The extent to which forests that are already certified for timber and pulp production can be elevated to include REDD certification is not yet clear. Forest certification requires good forest management that includes sustainable production. REDD (or at least REDD+) requires a system to reduce carbon loss through reduced impact logging or not logging at all. If a forest is already certified this implies that they are producing sustainably, which in turns suggests zero net carbon gain. Certifying such forest under REDD might not offer any additionality, and it is unclear whether such projects would qualify for REDD certification.

Considering the complexity of forest carbon certification the certification market is expected to be dynamic, with old standards phasing out or merging with others and new standards being introduced. The World Bank's recently-launched Forest Carbon Partnership Facility (FCPF) is viewed by many as an important catalytic initiative in this regard, and a number of organisations are eagerly awaiting the approval of the REDD approach being finalised by the FCPF, in order to understand how such credits could be developed (Forest Trends 2008).

5.2 Watershed services

Payment for watershed services (PWS) and water supply has a compelling logic. All life needs water, and only about 0.3 percent of the Earth's freshwater is contained in rivers and lakes, such surface water is an important source of water for drinking and irrigation (Vorosmarty *et al.* 2010). Protecting the sources of such water and paying those who look after related ecosystems seem obvious choices.

Debates about integrated conservation and development have caused a wave of excitement about PWS in recent years. But on the ground an equivalent surge of action is harder to see. There has been a lot of talk about ideals and considerable extrapolation of conclusions from a few case studies, mostly from developed or middle-income countries. In low-income countries, however, a recent global review of watershed services projects found that few efforts have been made to initiate and concertedly track the complex business of developing payments for watershed services (Bond and Mayers 2010). This review found that of the 42 initiatives analysed in an earlier (2002) study (Landell-Mills and Porras 2002), only 15 could be considered still active, while a further 3 remained at the proposal stage, and 21 (50%) had been abandoned or were of uncertain status. A different review found that in southeast Asia, most pilot schemes are small in size, difficult to manage and involve relatively high transaction costs (Neef and Thomas 2009). In fact, it has been argued that a focus on PWS schemes, of which few seem to fulfil their social and environmental goals, stands in the way of developing more promising PES schemes based on carbon (Pattanayak *et al.* 2010). Below are some of the main lessons learned from global reviews of PWS projects (Bond 2007; Bond and Mayers 2010).

Most existing PWS schemes are national programmes, not limited to a particular watershed, in which the government pays land managers to make specific land-use changes, though this is often poorly monitored and enforced (Engel *et al.* 2008; Bond and Mayers 2010). These programmes are neither truly voluntary nor based on market-led relationships and are vulnerable to changes in political priorities (Bond and Mayers 2010). Payments for watershed services can help reduce poverty and improve livelihoods but are not the best way to do this (Bond 2007) and may even work against those objectives. While evidence from some schemes shows modest increases in household incomes from PWS, the effects cannot be considered to represent substantial reductions in poverty (Huang *et al.* 2009). A focus on poverty alleviation in African PWS projects is thought to be one of the reasons why Africa has far fewer PWS initiatives than Latin America. The implied social targeting that comes with a focus on poverty alleviation increases the transaction costs and decreases the level of watershed services provided by PWS in Africa (Ferraro 2009). Thus, PWS schemes underperform both on the marketing of watershed services, and on poverty alleviation, when these objectives are combined. PWS can, however, be effective in building social capital (for example social networks among poor communities), as well as improved social cohesion, community confidence, and new entrepreneurial relationships. Such indirect effects have substantial potential to reduce poverty (Bond and Mayers 2010).

Bond and Mayer's review suggested little evidence that PWS schemes have had a significant effect on land and water management, although the schemes were generally still in their infancy and at pilot scale. The review generally confirmed a picture of very limited environmental effects of PWS, a finding confirmed in a more recent review (Pattanayak *et al.* 2010).

Awareness of market opportunities for PWS is low (Bond and Mayers 2010). Payments for PWS need to be big enough relative to other opportunities to create a real incentive for change. Changing farmers' behaviour requires that payments for watershed services are competitive with existing and perceived future net returns to land and labour. However, insufficient connections between suppliers and users of watershed services, coupled with social resistance to payment mechanisms in some contexts, were found to be major barriers for intermediary organisations.

In terms of existing and potential markets for PWS, private sector demand for watershed services is still low and most schemes are government driven (Pattanayak *et al.* 2010). Several large publicly funded schemes, including those analysed in China and South Africa, did not necessarily stimulate privately funded schemes and in some cases constrained them (Bond and Mayers 2010). Private landholders are the predominant suppliers of watershed services in user-based and national programmes, while communal landholders tend to be under-represented. Prices for watershed services are yet to be determined by the market, i.e. there are no market prices signalling the opportunity cost of supply to buyers, or willingness to pay to sellers (Muller and Albers 2004). In most cases, prices are set by administrators and intermediaries (Bond and Mayers 2010), and these might not accurately reflect market values, including opportunity costs (Börner *et al.* 2010).

Payments schemes for PWS projects vary from cash to in-kind, and from one-off to regular payments. The review by Bond and Mayers (2010) found that these diverse payments and mechanisms are a response to local conditions and watershed values, and differentiated payments within a particular scheme are practical. For example, one-off payments to help farmers move from one technology to another appear to be more realistic than in-perpetuity payments. In addition, a wide variety of other incentives for watershed management (i.e. tax breaks, free seedlings) are in play that may one day lead to PWS. Asymmetries in power, resources and information between stakeholders suggested that efficient price determination mechanisms are unlikely to develop in the near future (Bond and Mayers 2010).

In terms of geography, the African PWS market is still in its infancy, whereas those Latin America and Asia are more advanced. Latin America was found to be expanding the number and scale of PWS schemes. Asia is still mostly in an experimental phase, while, in Africa, schemes are yet to be developed.

From a financial point of view, PWS schemes will not be cost-effective where they are government coordinated, because of additional objectives such as poverty alleviation, regional development and employment creation (Wunder *et al.* 2008b). From a governance point of view, however, the government's role is essential, especially in defining and upholding land ownership (Wunder *et al.* 2005; Börner *et al.* 2010). Government legal and policy frameworks shape what is possible in PWS schemes. However, policy relating to PWS is frequently fragmented, perverse and based on simple hydrological models. Some governments, like those in China, Costa Rica, Mexico and South Africa, have become buyers of watershed services (Bond and Mayers 2010).

Little is known about the role of transaction and trust costs in successful PWS schemes. Developing, implementing and monitoring PWS mechanisms can lead to high transaction costs that undermine viability, compromise efficiency and jeopardise long-term sustainability (Neef and Thomas 2009). Transaction cost estimates from a project in Los Negros, Bolivia were US$23 000 over three years (Bond and Mayers 2010). In other projects, the transaction costs appeared to consume a significant part of the revenues created through the watershed services. Working through existing organisations, especially those on the supply side, is one way of reducing direct transaction costs. Trust between stakeholders also reduces transaction costs—but it is hard to build and easy to lose (Bond and Mayers 2010).

Finally, the review by Bond and Mayers (2010) highlights the role of technical capacity within PWS projects. Negotiated and adaptive approaches will only be achieved if capability in a range of disciplines is steadily built. Without adequate understanding of stakeholders' willingness to modify or maintain land use or water resource decisions, market-based mechanisms may prove to be unsustainable, with uncertain social and environmental outcomes (Hope *et al.* 2007). It is clear that in many attempted PWS schemes few individuals have the relevant expertise, and in some cases none. Initiatives to make expertise more accessible to those engaged with watershed issues, and to develop credible rapid assessment methods and other negotiation support tools, are sorely needed.

With regard to marketing and certification of PWS, Tognetti *et al.* (2005) pointed out a fundamental paradox. Given the complexity, natural variability and stochastic nature of multiple inter-dependent and site-specific factors that ultimately determine PWS outcomes, and the spatial and temporal separation of causes and effects between upstream and downstream, and between the present and the future, complete information is unobtainable and uncertainty is inherent. Market mechanisms, on the other hand, tend to be more effective when uncertainty is low, because buyers like to know if they are getting what they pay for. A precise determination of costs and benefits and their distribution, for purposes of establishing market values, presumes the ability to link actions and outcomes. Making uncertainty explicit may be a harder sell, but it is critical to managing buyer expectations and maintaining their cooperation in the long term (Tognetti *et al.* 2005).

Science is progressing fast on many of these hydrological and related issues, but we still do not have a full, system-wide understanding of how changes in the ecological integrity of watersheds translate into the quality and quantity of ecosystem system service provision. For watershed services, reliable certification would in principle be a good solution, but it might be impossible to reach any common acceptable, or even meaningful standard, because the provision of watershed services is extremely site-specific (Bruijnzeel *et al.* 2005). On the other hand, with improving understanding of the dynamics of PWS, the probability of doing the right thing in the right place is increasing, for example through the use of spatial optimisation models to assess costs and benefits of different land uses on watersheds (e.g. Quintero *et al.* 2009; Wilson *et al.* 2010).

Certification would require objectivity in the assessment of the ecosystem functioning and services and associated goods. Science may be able to give some guidance, but presently most PWS schemes depend on the subjective judgment of the service users: what model do they carry in their heads, and what do they want to believe? What is their risk aversion, to perhaps choose not the most likely 'profit-maximizing' but low-risk solution (S. Wunder, personal communication). Such subjectivity is well exemplified by a study in Central America (Kosoy *et al.* 2008) in which users involved in PWS schemes in three different countries uniformly agreed with the perception that 'more forest cover leads to more water quantity'—for which there is little scientific evidence (Bruijnzeel *et al.* 2005). It is revealing that a recent global review of projects focused on watershed services failed to note certification at all (Bond and Mayers 2010). Certification of watershed projects seems at present a bridge too far.

5.3 Services from species and landscapes

Access to natural areas and use of wildlife are important ecosystem services, which in many parts of the world remain free. There is no clear understanding of what these services exactly entail, but it seems their value can be considerable. For example, the global value of ecotourism was estimated at US$380 billion in 2006 (International Ecotourism Society 2006).

There is a need to differentiate between the functional and compositional aspects of services from natural areas and species. Some authors include all services and goods that can be obtained and marketed from species in an ecosystem, e.g., forest coffee, spices, bamboo, honey and wax, as well as pollination services by forest insects (van der Beek *et al.* 2006, Smith 2007). We consider these as ecosystem goods and discuss these further in a section below (see Non-Timber Forest Products).

One service provided by species and landscapes is economically valuable pest control. An example of this is birds that reduce coffee pests in Jamaica, resulting in a greater quantity of saleable fruits than in areas where birds are excluded (Kellermann *et al.* 2008). The 'existence value' of species and landscapes is also an important service which can generate payments for the purpose of maintaining biological diversity. In addition to these, there are also 'perceptional values', such as landscape beauty. Such perceptions of aesthetic value are highly subjective and therefore difficult to market and certify, as standardisation would be highly problematic. This does not mean that perceptional values have no economic worth. For example, the total recreation fee revenue for the Grand Canyon National Park, a park most often visited for its views, was US$9.8 million in 2006 and averaged US$14.7 million in the 10 years prior to 2006 (National Parks Service 2007). Certifying those views would, however, be challenging.

The difficulty of quantifying services from species and landscapes might have affected the slow development of markets for nature conservation, although many approaches are emerging to remunerate the owners and managers of land and resources for their good stewardship of nature. These include bioprospecting rights, payments for ecotourism uses, and markets in tradable wetland mitigation or biodiversity credits, whereby developers are required to buy credits or offsets generated by biodiversity enhancements that have been carried out elsewhere (Jenkins *et al.* 2004). Private investors also finance nature conservation deals, such as the Malua BioBank, in Sabah, Malaysia. Biodiversity banking and offsets are financial schemes designed to compensate forest owners with biodiversity credits for maintaining forests and biodiversity on their lands. These credits can be sold to developers to offset the impacts on biodiversity of development on lands elsewhere (Ghazoul *et al.* 2010).

Another example of payments for species and landscape services is provided by the many community-focused wildlife and ecotourism projects, of which CAMPFIRE in Zimbabwe is a good example. This is a community-based natural resource management programme in which rural district councils, on behalf of communities on communal land, are granted the authority to market access to wildlife in their district to safari operators. These in turn sell hunting and photographic safaris to mostly foreign sport hunters and eco-tourists. The district councils pay the communities a dividend according to an agreed formula (Frost and Bond 2008). This approach has been successful as measured by a range of environmental and social indicators, although the programmes remains reliant on outside, especially donor funding (Taylor 2009).

It is unclear to what extent payments for biodiversity services could be certified. Quantification and commoditisation issues might make it hard to develop certification standards that could be applied globally. One area where this is happening is in the certification of ecotourism, where particular projects are judged based on social and environmental criteria (Bustam and Buta 2009). What may also be possible is that biodiversity values can be bundled with other services, as in the identification of 'high conservation value forest' (HCVF), required by the FSC for certification of timber and pulp producing forests and plantations. However, even if co-benefits between biodiversity and other forest ecosystem services are sought through combined certification schemes, the two are not always linearly related and trade-offs need to be considered (Venter *et al.* 2009a). Bundling of different ecosystem goods and services in certification procedures should carefully consider these tradeoffs by independently assessing the costs and benefits of ecosystem service trade for different values (e.g. biodiversity conservation) to judge how bundling affects the overall outcomes for these potential co-benefits.

One possibility for developing ideas on how species and landscape services could be certified is to pilot certification criteria for organisations whose core-business is conservation. Many questions have been raised about the lack of accountability and transparency in conservation (Stem *et al.* 2005; Ferraro and Pattanayak 2006; Brooks *et al.* 2009), and conservation organisations have generally taken steps to develop tools for monitoring conservation progress, return on investment, and adaptive management. These organisations are well positioned to develop a certification process that sets criteria for good planning and monitoring, transparent administration, effective and efficient use of resources, and community-friendly management.

5.4 Pollination

Pollination services from forest ecosystems have attracted a considerable amount of scientific attention and are recognised as making significant economic contributions to human societies (see Guariguata and Balvanera 2009 for a recent review). For example, commercial crops such as robusta coffee (*Coffea canephora*) benefit from a species-rich and abundant bee assemblage, which in turn depends on the preservation of natural forests and forest fragments in the vicinity (<500 m) of those coffee agroforestry systems (Klein *et al.* 2003). In the United States of America, native bees are estimated to make an annual contribution to the production of fruits and vegetables of US$3 billion (Losey and Vaughan 2006). Bats also play an important pollination role. Fujitta and Tuttle (1991) found that at least 289 Old World plant species rely to varying degrees on bats for pollination or seed dispersal. One of the favourite fruit trees in Asia, the durian (*Durio* spp.) is pollinated by bats. The durian trade in southeast Asia was valued at US$120 million in the mid-1980s (Myers 1985). Loss of forest can lead to local loss of bats and failure of valuable durian crops (Start and Marshall 1976). Finally, nectar feeding birds are also important for the pollination of a great number of flowers, although not many examples are known of commercial species that require pollination by bird species (Fleming and Muchhala 2008). Overall it appears that insects are more important in pollination than birds and mammals, although this varies geographically and between crop species. In the case of agricultural crops, both social and solitary bees are by far the most important pollinator group (Klein *et al.* 2007).

Guariguata and Balvanera (2009) reported on the considerable amount of research available on the relationship between pollination and land-use change (e.g. Kremen *et al.* 2007). The economic importance of pollination is debated: Some argue that agricultural inputs such as water, fertilisers, and pesticides are more critical to crop productivity than pollinator limitation (Ghazoul 2007) and that crop revenues override the opportunity costs of maintaining natural habitat as pollinator refugia on or near farms (Olschewski *et al.* 2006). Similarly, it has been argued that decreased crop productivity due to pollinator limitation can be compensated by increasing the area planted (Aizen *et al.* 2008). This comes at a cost, though. The expected direct reduction in total agricultural production in the absence of animal pollination is 3%–8%, but the percentage increase in cultivated area needed to compensate for these deficits is several times higher, particularly in the developing world (Aizen *et al.* 2009). Another factor discouraging habitat-based PES schemes on pollination may be the relatively high spatial sensitivity of tropical insect pollinators to habitat loss (Ricketts 2004), making this ecosystem service very location specific and requiring a concentration of both 'providers' and 'beneficiaries' of the service in a given place (Guariguata and Balvanera 2009). Pollination is poorly represented in the pool of marketable services from forests. Most of the pollination services for which there is a market are not habitat based (that is, conserving forest patches for provision of pollination, e.g. Carvalheiro *et al.* 2010) but are provided by either importing pollinators and letting them naturalise (e.g. oil palm planted outside Africa) or placing beehives for a determined period of time so that bees can fulfil the pollinator role. This is the case for the almond industry in the United States, where natural and semi-natural habitats no longer surround almond farms due to agricultural intensification and the service is provided by private beehive owners. Such pollinator services are in direct competition with natural pollination services from forests. Evidently a global market for pollination services exists (Allsopp *et al.* 2008) but so far it is largely divorced from the argument of conserving habitat to provide this particular service, especially when insect pollination is known to increase fruit yield but is not deemed 'essential' (Klein *et al.* 2007). Even for those crops where cross-pollination by insects is essential for fruit set (e.g. passion fruit, *Passiflora edulis*), manual pollination remains cost-effective in the face of intensification (see Calle *et al.* 2010).

Similar to the limitation in pollination markets, certification of pollination services only occurs in situations separate from a natural ecosystem setting. For example, there are certification schemes for pollination friendly gardens and for pollination services. None of these are linked to broader forest services. Certification processes for natural pollination services have a long way to go.

5.5 Disaster prevention and risk reduction

Every year, disasters related to meteorological, hydrological and climate hazards cause significant loss of life, and set back economic and social development by years. Between 1980 and 2005, nearly 7500 natural disasters worldwide took the lives of over 2 million people and produced economic losses estimated at over US$1.2 trillion. Of this, 90% of the natural disasters, 72.5% of casualties and 75% of economic losses were caused by weather- and water-related hazards such as droughts, floods, windstorms, tropical cyclones, storm surges, extreme temperatures, landslides and wild fires, or by health epidemics and insect infestations directly linked to meteorological and hydrological conditions (World Meteorological Organization 2010). There are many links between the health of ecosystems and the occurrence of natural disasters; however, these links are often over-simplified in the media, for instance in the description of relationships between watershed deforestation and floods (Kaimowitz 2005; Calder *et al.* 2007; van Dijk *et al.* 2009), or the value of coastal ecosystems in reducing the impact of tsunamis (Cochard *et al.* 2008).

It is unclear how the value of ecosystems in disaster prevention could be marketed or certified. Economic losses through natural disasters are indeed very large and increasing, and it could be envisaged that payments from the public, for example through taxation, could maintain sustainable ecosystems and reduce potential costs of natural disasters. To certify such systems, however, would require a clear understanding of the state of forest ecosystems and the financial values this would have in reducing costs from natural disasters. Considering the complex interactions between ecosystems and the causes of disasters, it is unlikely that these relationships could be robustly substantiated, although our understanding of landslides and floods is improving.

Finally, one potential area where certification of ecosystem services for prevention of natural disasters could develop is in the insurance industry. Some initiatives already link insurance premiums at the community level to floodplain management and link this to some certification scheme (see www.nationalfloodinsurance.com). With the cost of natural disaster rising, a market may develop that would allow payment for better management of protecting natural ecosystems. The next step to certification of such schemes may then not be too far off.

5.6 Fisheries and other services from coastal forests and mangroves

This review primarily focuses on inland forests, but mangroves and other coastal forests also have an important economic value and provide many ecosystem services, and it is worth briefly highlighting these. The undervaluation of natural products and ecological services generated by mangrove ecosystems is a major driving force behind the conversion of this system into alternative uses (Rönnbäck 1999). Human exploitation of mangrove resources has a long history, especially in conversion for mariculture, agriculture, urban development and harvest for fire wood, leading to rapid loss of these forests (Valiela *et al.* 2001). Over the past 50 years, approximately one-third of the world's mangrove forests have been lost, although most data show highly variable loss rates and most estimates have a considerable margin of error (Alongi 2002). Mangroves are a valuable ecological and economic resource, being important nursery grounds and breeding sites especially for fish and crustaceans, but also for birds, reptiles and mammals. They are also a renewable source of wood; accumulation sites for sediment, contaminants, carbon and nutrients; and offer protection against coastal erosion (Alongi 2002). One study conducted in Bintuni Bay, West Papua, estimated that traditional uses of the 300 000 ha mangrove area by the 3000 local inhabitants of the bay were valued at US$10 million per year (Moosa *et al.* 1996; Giesen *et al.* 2006). A global study suggested that the market value of fisheries dependent on mangrove habitat was up to US$16 750/ha per year (Rönnbäck 1999).

Some initiatives to certify the use of mangrove forest have been implemented. The German organisation Naturland combines reforestation of mangroves with the promotion of ecologically friendly shrimp breeding. The shrimps have to be bred without chemicals and at least half of the area used for aquaculture has to be covered by mangrove trees (Naturland 2010). Apart from programmes focused on shrimp farming, few certification schemes specifically address mangroves. The FSC classifies mangroves as High Conservation Value 3, (i.e. 'forest areas that are in or contain rare, threatened or endangered ecosystems'), but because the organisation focuses on commercial forest areas, and timber production values in mangroves are low, certification of mangroves is unlikely. In larger certified forest landscapes that combine coastal and inland forests, mangroves may be set aside for their high environmental and social values. This is most likely how mangroves will be incorporated into any potential future certification scheme for ecosystem services, i.e. as a subset of a broader forest certification process, although certification for specific products from mangrove areas might play some role.

5.7 Non-timber forest products

Non-timber forest products (NTFP) are any commodity obtained from the forest that does not necessitate harvesting trees. They are ecosystem goods rather than services. We discuss these here because some ecosystem services might be bundled with certification of NTFPs.

NTFPs include game animals, fur-bearers, nuts and seeds, berries, mushrooms, oils, foliage, medicinal plants, peat, fuel wood and forage (Shanley *et al.* 2002). Considering the incredible diversity of species in the world's forests, the range of NTFPs is very large. Perhaps the biggest problem in describing these products is the lack of information concerning the distribution systems used to get the products to final consumers. NTFPs are found in a wide variety of outlets, unlike timber-based forest products (Chamberlain *et al.* 1998).

The most important value of NTFPs lies in their subsistence uses (e.g. medicine, food, shelter) and trade in local markets, as well as international markets for some products. A review by Shanley *et al.* (2008) pointed out the significant economic importance that NTFPs have to poor communities, especially in developing countries, but also in industrialised ones. Farnsworth (1985) estimated that, 25 years prior to his study, 80% of the world's population still relied on traditional, largely plant-based, medical systems for their health-care needs. This is likely to have reduced significantly since then, but NTFPs are still estimated to account for as much as 25% of the income of close to 1 billion people (Molnar *et al.* 2004 in Shanley *et al.* 2008).

The FSC has, since 1998, permitted certification of NTFP management systems on a case-by-case basis. The first FSC approved NTFP certification, granted by SmartWood to an operation harvesting chicle (a tropical evergreen tree exudate used for chewing gum) in Mexico, occurred in 1999. Since then, certification for other NTFPs has followed including: Açaí (*Euterpe oleracea*), maple syrup (*Acer saccharum* and closely related species), rubber (*Hevea brasiliensis*), brazil nuts (*Bertholletia excelsa*), medicinal plants, and venison (certified by SGS). Many others are being developed, including bamboo, yerba mate (*Ilex paraguariensis*), and pine nuts (*Pinus* spp.) (Smartwood 2002), as well as chestnut (*Castanea* spp.) production in Greece, and cork (*Quercus suber*) in Spain (Donovan 2000). Another example of successful certification of an NTFP is forest honey, for example through BIOCert, an organic certifying body in Indonesia. Certification under this system requires sustainable harvest techniques, stable land tenure, the presence of local institutions that can monitor sustainable harvest methods, the presence of culturally appropriate sanctions to ensure compliance with regulations, well-managed forest, and controlled honey production techniques (Anonymous 2005).

Wiersum (2006) distinguished four principle types of NTFP certification schemes: FSC certification based on sustainable forest management criteria; organic crop production schemes; fair trade certification schemes; and area-based schemes for certification. Of these the FSC systems seems most relevant to the issue of certification of forest ecosystem services.

Despite the economic value of NTFPs, their wide use among forest-based communities, and the proliferation of various niche market certification systems, Shanley *et al.* (2008) listed several reasons why certification of NTFPs could be difficult:

- the wide array of products encompassed by the term 'NTFP';
- the complexity of chain-of-custody systems for NTFPs, which often involve a number of middlemen;
- the diverse plant forms and plant parts used (e.g. exudates, vegetative material, reproductive propagules) compared with only trees and stems in timber certification;
- the wide range of NTFP end uses (e.g. food, personal care products, botanical medicines, handicrafts etc.) compared with the timber and pulp market; and
- the greater degree of overlap with other certification schemes (e.g. ecological, organic, fair trade, quality control), which makes collaboration across schemes more important.

This study is concerned with certification of forest-based ecosystem services, which should guarantee the sustainable management of those forests. It is unclear how the individual certification systems for different NTFPs, even when linked to broader forest certification systems such as the FSC, can develop into significant markets that help the sustainable management of forests. One could argue that NTFPs harvested from forests managed for timber under FSC standards could further promote sustainable forest management and perhaps facilitate harmonisation of standards. For example, economically valuable NTFPs such as Brazil nuts are sometimes extracted from forests in Bolivia where FSC certified timber is harvested. Additional management benefits are obtained by applying pre-harvest marking of pre-reproductive Brazil nut trees along with the future crop individuals of timber species, and by applying directional felling to reduce crown damage to reproductive Brazil nut trees (Guariguata *et al.* 2009). Recently, the extraction of understory palm fronds (*xate*) has been awarded FSC certification in three community forestry concessions in Guatemala where FSC-certified timber is also harvested (Pinelo 2009). In FSC certification of timber, it is not the harvest of individual species, but rather management of the entire forest that is certified as sustainable using community-level data; in contrast, FSC certification of NTFPs certifies as sustainable a given harvest volume of a particular species, supported by species and population-level data. In that sense, the NTFP systems could be considered tighter, and when bundled with other ecosystem service certification would provide an additional level of control—as well as management complexity—that might aid sustainable management of forest resources.

6 An overview of relevant forest certification schemes

The idea of independent forest certification was first proposed by the International Tropical Timber Organization (ITTO) at the beginning of the 1990s, but was not realised in practice. The first practical and working example became the Forest Stewardship Council (FSC), founded in 1993 by environmental nongovernmental organisations (NGOs) and retailers, with support from some US foundations. Other systems were developed and introduced as a response to the FSC, generally by the forest industry sector. The other schemes, developed by the forest industry, are often less strict in areas relating to stakeholder involvement, biodiversity conservation, indigenous people's rights protection and social issues (Ptichnikov and Park 2005).

There are over 30 different forest certification systems, depending on how one counts (Table 3). At a more general level, however, they are converging around two alliances, one centred on the NGO-oriented FSC and the other centred on the forest production-oriented Programme for the Endorsement of Forest Certification Schemes (PEFC) (Meidinger *et al.* 2003).

Initially, the FSC began by defining a relatively strong set of programme-wide requirements and then adapting them to the degree necessary to respond to local differences. The PEFC began by defining a much looser set of programme-wide criteria and then building local programmes (Meidinger *et al.* 2003). Over time, however, both programmes have had to address the issue of achieving decentralised consistency.

Thus the FSC is facing considerable pressure from some of its national and regional working groups to allow more the flexibility for decisions made in local standard setting processes. The PEFC, on the other hand, is facing increasing pressure to build greater credibility, which often means consistency, into its programme. This often involves deploying improved mechanisms for monitoring and assessing forestry operations, including more detailed and consistent assessment protocols and better accreditation, auditing and information management systems (Meidinger *et al.* 2003). But all of these improvements cost money, and the programmes are simultaneously under pressures to keep costs down, since they must be remunerated by the forestry operations they certify and are in competition with each other. These countervailing pressures create strong incentives for the programmes to observe each other closely, and to adopt innovations made by the other programme.

The main certification systems will be reviewed briefly to provide background information for the discussion on developing certification schemes for ecosystem services.

6.1 Forest Stewardship Council

The FSC has focused primarily on management of natural and planted forests for the production of timber and fibre. The FSC Principles and Criteria, however, have relevance for the certification of other ecosystem services too and new single issue standards are being developed, for example for

Table 3. Forest certification systems and areas of certified forest

Certification system	Hectares of forest certified[a]
FSC International	135 420 000
PEFC International	223 000 000
Sustainable Forestry Initiative	close to 80 million
American Tree Farm System	10 521 827
Czech Council of the National Certification Centre	Unclear
Canadian Standards Association	69 000 000
Finnish Forest Certification Council	2 764 924
Certificación Forestal Chile	1 600 000
Certificação Florestal Brasil	800 000
Lembaga Ekolabel Indonesia	1 578 000
Australian Forestry Standard	10 267 513
Living Forests Norway	7 397 000
Standards Council of Canada	79 300 000
Certificación Española Forestal	(in 2004)1 200 000[b]
Malaysian Timber Certification Council	972 237

a Some of these areas are covered under multiple certification systems.
b From 2004

Source: A range of web-based sources in September 2010

carbon sequestration. The hallmark of the FSC is to promote the long term sustainability of forest areas through minimising environmental impact and preserving high conservation values while delivering benefits to local communities and ensuring their participation, including for example that of indigenous peoples. The FSC believes that compared to many other standards being developed, especially in the carbon context, its systems have the breadth of coverage that others lack. For example, other standards do not normally cover the International Labour Organization (ILO) core conventions and indigenous peoples' rights—on the social side—and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)—on the environmental side. In 2010, the PEFC was considering the incorporation of social requirements based on the ILO core conventions in their certification criteria, but the proposal was strongly opposed by the US Chamber of Commerce (Gunneberg 2010), and has not yet been endorsed by PEFC.

The FSC has pioneered the concept of protecting through certification 'high conservation value forests', which could be relevant to forest carbon, water or non-timber forest product (NTFP) programmes. The FSC therefore considers it increasingly pressing to expand and adapt its certification system as a proven tool for well-managed forests in contexts other than timber production (FSC 2010a). An example of the broadening of the FSC's horizon is the Mapanda and Uchindele project in Tanzania, which aims to reforest 10 800 ha of degraded grassland with pine and eucalyptus for carbon sequestration and sustainable harvest. The project is certified under the Voluntary Carbon Standard (VCS), FSC, and Climate, Community and Biodiversity Alliance (CCBA), and Green Resources forecasts US$1.5 million in carbon credit sales in 2010. A recent review by Forest Trends (2008) found promising signs for the FSC in its aims to expand its certification. In particular, it suggested that a rapid growth in demand for chain-of-custody forest certification will stimulate future demand for sustainable forest management certification. This is likely to drive increased demand for forest carbon offsets and associated certification, with combined certification of forests and payment for ecosystem services (PES) being a useful delivery mechanism. Whether the FSC will be able to meet that demand is unclear.

Overall the FSC has seen more success in developed than developing countries, in terms of the amount of forest certified and number of chain-of-custody certificates issued, raising questions as to its ability to promote biodiversity (Gulbrandsen 2004; Dennis *et al.* 2008). Also, it appears that the FSC has more significance in industrial forestry compared to PEFC-based schemes, which are more effective in nonindustrial private forests, at least in temperate forests (Federation of Nordic Forest Owners' Organisations 2005). The FSC seems a prime candidate for speeding up the development of ecosystem service certification, although like other certification schemes, it needs to overcome a range of hurdles, including output and market access and cost of certification (Schepers 2010).

6.2 Programme for the Endorsement of Forest Certification Schemes

Forest owners and the timber industry started the Programme for the Endorsement of Forest Certification Schemes (PEFC) in 1999 as an umbrella scheme for national forestry standards. Pattberg (2005) stated that unlike the FSC, the PEFC does not rely on independent on-the-spot inspections. Nor does it demand annual inspections and only applies random checks. According to the PEFC (2007), however, both forest management and chain-of-custody certifications require a maximum period for surveillance audits of one year and a maximum period for reassessment audit of five years. The PEFC also specifies that the auditors shall fulfil general criteria for quality and environmental management systems auditors as defined in ISO 19011.

Founded primarily as a reaction to the success of the FSC, the PEFC has successfully challenged the FSC, currently covering more than 200 million hectares of certified forest, mainly in Europe and North America. It works by endorsing national forest certification systems, about 30 so far, developed through multi-stakeholder processes and tailored to local priorities and conditions (PEFC 2010). Endorsement follows a set number of steps. The first is the creation of a national Forum for Standard Setting, which includes representatives from all interested stakeholder groups. Once created, the forum will announce the start of the standards development process. It will issue regular updates on progress to enable engagement by interested stakeholders at any or all stages of the process and to keep all interested parties fully informed of proceedings. Once the forum has agreed a draft standard, it will initiate a 60-day national-level public consultation to seek further inputs and comments. Following the consultation period, the forum will publicly communicate information on changes and amendments resulting from this process. Pilot testing of national standards is another required element, with lessons learned being incorporated into the standards. Following this phase of development, the standards are finalised for implementation. Finally, the standards must be formally approved based on the evidence of consensus within this forum.

Standards development does not stop once a national standard has been finalised. The PEFC requires and implements 5-year revisions of national standards. Consequently, PEFC recognition of national standards is time-limited, with the national system being required to apply for re-endorsement. This allows for continuous improvement of standards through the integration of new scientific research, experience and best practices. Equally important, however, it encourages permanent dialogue among stakeholders, thereby enhancing understanding, support and development of the concept of sustainable forest management at the national level.

6.3 American Tree Farm System/ Sustainable Forestry Initiative

Founded in 1941, the American Tree Farm System (ATFS) originated as a way for private landowners to indicate the sustainable management of their forest lands to the public. For more than four decades the programme continued to grow primarily as a public information and education forum that included a mix of industrial forests and small forest enterprises. As forest certification systems began to develop in the 1990s, the ATFS took the opportunity to grow into a full-fledged third-party certification system. This growth was prompted in part by the development of the Sustainable Forestry Initiative (SFI). This initiative was launched in 1994 by the American Forest and Paper Association (AF&PA) in response to public concerns about the sustainability of forests and to guide industrial members in standards for sustainable forest management. The SFI has grown to include over 54 million ha of primarily industrial forest lands in the US. The standard certification procedures have also gone through a number of revisions designed to address a wider array of sustainable forestry issues, to provide the option of third-party audits, to deploy an eco-label and to give the programme a third-party identity separate from AF&PA. Currently, the programme is overseen by the Sustainable Forestry Board, an entity separate from the AF&PA. The SFI is mostly oriented towards large industrial forests (Butterfield *et al.* 2005).

6.4 International Organization for Standardization

The International Organization for Standardization (ISO) is a non-profit organisation which establishes global standards for various products, production processes and services to ensure that they meet acceptable levels of quality. Many national standards have emerged to ensure environmental safety, which has prompted the ISO to also develop environmental standards. As a result, the ISO 14000 series of international standards on environmental management were introduced in 1996. Of all the standards in the ISO14000 series, ISO 14001 for environmental management systems (EMS) is the only standard against which it is currently possible to be certified by an external third-party certification authority. The certification process includes identification of environmental aspects of the operation which pose high risk to the environment, setting objectives and targets to reduce the environmental impacts, identification of changes required to meet the goals and objectives, implementation of new practices and continuous evaluation of their effectiveness. This is more a process-based certification system and is applied at the level of entire enterprises. It does not include specific, on-the-ground standards for forest management, but focuses on improved environmental planning. The ISO 14001 system gained wide acceptance around the world largely due to recognition of the ISO. Many companies also prefer their forests to be certified under dual certification programmes, one often being the ISO standards. Of additional relevance to ecosystem service certification is ISO 14064. This specifies principles and requirements at the organisation level for quantification and reporting of greenhouse gas emissions and removals. It includes requirements for the design, development, management, reporting and verification of an organisation's greenhouse gas inventory, including carbon emissions (Perera and Vlosky 2006).

6.5 Climate, Community and Biodiversity Alliance

The Climate, Community and Biodiversity Alliance (CCBA) is probably the most advanced with regard to certification of ecosystem services besides timber. The preparation of a Project Design Document (PDD) is central to the CCBA certification process. The PDDs contain detailed project descriptions, including the preproject state of biodiversity, the anticipated ecological effects of project activities and a monitoring plan (Entenmann 2010). This certification process thus bundles various ecosystem services, and addresses a number of ecological and socio-economic targets. As of June 2010, eight projects avoiding deforestation and forest degradation had submitted their PDDs to the CCBA (Table 4).

CCBA certification is based on the FSC's concept of 'high conservation value forests' for the identification of ecological and social values. It is difficult to see though, how baseline values or trends would be developed for these values and how they could be marketed and certified alongside carbon values. Presumably, the CCBA aims to certify carbon and market concomitant ecosystem services such as watershed and biodiversity protection as unmeasured co-benefits, although some projects, such as Oddar Meanchey did prescribe participatory monitoring methods for measuring the impact of management on wildlife population levels. The CCBA uses a set

Table 4. REDD+ pilot projects audited under the CCBA

Project	Country
Genesis Forest Project: Reforestation of Brazilian Savannah Native Species in the State of Tocantins	Brazil
Juma Sustainable Development Reserve Project: Reducing Greenhouse Gas Emissions from Deforestation in the State of Amazonas	Brazil
Kasigau Corridor REDD Project Phase 1—Rukinga Sanctuary	Kenya
Madre de Dios Amazon REDD Project	Peru
Mitigation of Greenhouse Gas Emissions through Avoided Deforestation of Tropical Rainforests on Privately-owned Lands in High Conservation Value Areas of Costa Rica	Costa Rica
Peñablanca Sustainable Reforestation Project	Philippines
Reduced Emissions from Deforestation and Forest Degradation in Oddar Meanchey Province	Cambodia
Reducing Carbon Emissions from Deforestation in the Ulu Masen Ecosystem, Aceh	Indonesia

Source: Entenmann (2010)

of standards, in which projects must generate exceptional biodiversity benefits to receive the 'gold' level of the CCB Standard and must prove that species listed as threatened in the International Union for Conservation of Nature (IUCN) Red List are protected, or that project activities include the protection of irreplaceable sites according to the Key Biodiversity Area (KBA) framework (Entenmann 2010).

6.6 National level certification schemes

Despite significant efforts, the take up of forest certification, especially in tropical forests has been less than hoped for. For example, as of November 2007, only 800 000 ha of natural forest in southeast Asia was FSC-certified, with some additional planted forest areas (totalling 63 653 ha) in Thailand and Vietnam (Dennis *et al.* 2008). By November 2010, this had increased to 1 410 341 ha for all FSC-certified forest areas in southeast Asia (FSC 2010b). Compared to this, national certification schemes appear to have been more successful. For example, the Indonesian Ecolabelling Institute (Lembaga Ekolabel Indonesia, LEI), established in 1992, had certified, as of June 2010, 1.1 million ha of natural forests, 453 000 ha of plantation forests, and 25 000 ha of community forests in Indonesia alone (LEI 2010). In Malaysia, the Malaysian Timber Council Scheme (MTCS) has given MTCS Certificates for Forest Management to three concessions totalling 972 237 ha of natural forest, while an additional 3 968 848 ha have been certified by the Programme for the Endorsement of Forest Certification Schemes (PEFC) (see above) (Malaysian Timber Certification Council 2010). The data from these two countries seem to suggest that national certification schemes are growing more rapidly than international schemes such as the Forest Stewardship Council. It is unclear, however, whether these national schemes could be upgraded to include the certification of ecosystem services. The reliance on internal standards and lack of third-party audits might be difficult to reconcile with demands from international markets for clearly quantified ecosystem services.

6.7 Fairtrade

Fairtrade is a product certification system designed to allow people to identify products that meet agreed environmental, labour and developmental standards. It is overseen by a standard-setting body, Fairtrade Labelling Organizations International (FLO), and a certification body, FLO-CERT. The system involves independent auditing of producers to ensure the agreed standards are met. Companies offering products that meet the Fairtrade standards may apply for licences to use the Fairtrade Certification Mark (or, in North

America, the applicable Fair Trade Certified Mark) for those products. The FLO international certification system covers a growing range of products, including bananas, honey, oranges, cocoa, coffee, shortbread, cotton, dried and fresh fruits and vegetables, juices, nuts and oil seeds, quinoa, rice, spices, sugar, tea and wine (FLO-CERT 2010). Only some of these, like forest honey, might be relevant to ecosystem service certification where they can be bundled with these services.

7 Challenges and barriers to certification of ecosystem services

Despite significant progress, forest certification, especially in tropical countries, has fallen short of its goal to promote sustainable forest management in large areas of forest (Dennis *et al.* 2008; Purbawiyatna and Simula 2008; Schulze *et al.* 2010). In April 2008, it was estimated that only 1.5% of the remaining tropical and subtropical forests had been certified (Bennett 2008). The following factors have been highlighted as the main barriers to progress in forest and timber certification in the tropics: lack of skills and adequate management systems in forest management units, obstacles to accessing certification services, limited awareness of the importance of certification, and lack of certifiable timber (Purbawiyatna and Simula 2008). These factors will likely obstruct the certification of ecosystem services as well, although the complexity of those services makes the development of a global certification system that fits specific local forest and governance conditions even more challenging.

Another important barrier to ecosystem service certification is a lack of demand. As discussed above, certification for timber seems to be driven more by nonmarket factors than market factors that originate from buyers, although there are notable exceptions, such as timber certification in the Congo Basin (R Nasi, personal communication). It is difficult to judge what determines demand for ecosystem service certification. Is the demand coming from verifier organisations, such as the Forest Stewardship Council (FSC), that are promoting certification? Is demand going to come from governments, such as the Government of the Netherlands' commitment to source 100% certified timber for its own timber needs. Or is the demand coming from buyers of carbon, water and other services and goods? Alternatively, does demand come from the sellers' side, where competition among ecosystem service projects is creating an incentive to associate with certification systems? Without clear answers to these questions we cannot judge whether demand is sufficient and market support adequate to make certification economically viable. Knowing whether demand is mostly driven by buyers, sellers, verifiers, or a combination of these is important for determining how to increase demand. Does that require market pressure, advertising, or policy commitments from governments?

This review has highlighted challenges specific to the certification of ecosystem service projects—and to making such projects work in the first place—including the role of geographic scales and distribution of ecosystem services, issues of land tenure and jurisdiction over specific ecosystem services, monitoring and verification issues, and the role of regulatory frameworks. We summarise these challenges below and look for possible solutions, specifically addressing how these relate to ecosystem service certification.

7.1 The role of landscape scales and geographic distribution of ecosystem services

Geographic variables may affect the success of certification for forest-based ecosystem services. The geographic scale of projects for different ecosystem services could vary greatly (Table 5), suggesting that different certification methods might be required. This does not take into consideration payment for ecosystem services (PES) projects with forest components designed at country level, such as the Pagos por Servicios Ambientales programme in Costa Rica (Pagiola 2008) and the Payment for Hydrological Environmental Services programme in Mexico (Muñoz-Piña *et al.* 2008), for which certification seems logistically and organisationally very challenging. These projects also raise the question of whom certification would be for, since the buyers are a single market of in-country service users.

The geographic scale of a certification process is important because it influences the cost-effectiveness. Certifying non-timber forest products (NTFPs) from a 10 ha community forest, allows for far more detailed certification procedures and monitoring criteria than a 1 million ha forest area certified for biodiversity, carbon, and watershed services. Relative costs of small projects are, however, likely to be higher than large ones (Tacconi *et al.* 2003). This might explain why smallholders seldom achieve the requirements of more stringent schemes such as FSC certification without considerable external support (Grieg-Gran *et al.* 2005; Ghazoul 2010). This issue will likely be the same for certification of forest ecosystem services projects: more detailed and stringent principles and criteria as well as third party verification requirements come at high costs that only the large projects can absorb, unless mechanisms are found that can significantly reduce the transaction costs for small projects.

Table 5. Ecosystem services and project scales

Ecosystem services and goods	Geographic scale of projects (in ha, in orders of magnitude)
Carbon sequestration	1 000–1 000 000
Watershed services	10 000–1 000 000
Biodiversity	1 000–10 000 000
Pollination	1–1 000
Disaster risk prevention	10 000–10 000 000
Fisheries and coastal forests	10–100 000
Non-timber forest products	1–10 000

Source: Erik Meijaard, various internet sources

In addition to project scale, the geographic location of a certification project will also affect the likelihood of success. A study comparing the uptake of international forest certification (in Finland, Russia and Sweden) illustrated that local infrastructure and market characteristics defined the choice and implementation of certification type as well as the eventual outcome of the implemented scheme (Keskitalo *et al.* 2009). Such differences exist between sites and countries as well as broader regions, such as between tropical and temperate areas. In fact, the global differences in certification success pose a dilemma: certification has been most successful in temperate forests, but ecosystem service certification appears to be most suitable for carbon sequestration projects, and their geographic focus is in the tropics. With carbon sequestration a likely candidate for pilot projects on ecosystem service certification, it seems logical to focus on large-scale projects in tropical forests with relatively simple certification criteria. The question is whether governance, management and auditing capacity, as well as certification standards are sufficient to satisfy the requirements of carbon buyers, not just in terms of delivered carbon services, but also the social and environmental values that would be protected by such a standard.

Another possibility is the certification of ecosystem goods such as NTFPs, eco-beef, shade-grown coffee, etc. Many projects marketing these goods have established certification criteria, such as those under the Fairtrade system. These projects are especially relevant for small-scale producers, and are unlikely to be managed across large landscapes, unless the landscape-level certification ideas, such as those promoted by Ghazoul *et al.* (2009, 2010), gain broader acceptance.

An important final issue relates to land use in forests designated for ecosystem service certification. In a review of sustainable forest management in tropical forest, Nasi and Frost (2009) stated that 'the battle to conserve most tropical diversity will be won or lost in managed forests being used to produce timber and other goods', because protected areas alone will be insufficient and the capacity to expand the existing protected area network is inadequate. Traditionally, forest certification has mostly focused on commercial forest concessions, because here monitoring of the implementation of sustainable management according to certain criteria and indicators has direct relevance for markets that demand forest products. This raises the question as to whether certification of ecosystem services should also focus on forests that are not used, such as strictly protected areas. Does it make sense to certify an area where, through legislation, extractive uses are already prohibited or limited? It would certainly raise the 'additionality' issue, unless a clear case can be made that without payments for ecosystem services revenues from a park would be insufficient to sustain protection of the forest (Wunder 2007; Pattanayak *et al.* 2010).

7.2 Monitoring and verification challenges

Monitoring is a key aspect of certification that should ensure that certified forests continue to fulfil the agreed principles and criteria. Monitoring provides buyers of certified goods and services evidence that these are obtained from sustainably managed forests. Also, monitoring assists forest managers in the adaptive management of their area, helping them to assess whether certain strategies are effective and efficient, and if not, how these could be adapted (Salafsky *et al.* 2002). Such science-based evaluations that could potentially clarify relationships between management strategies and sustainability goals are, however, rare (Sutherland *et al.* 2004; Sutherland 2005; Ferraro and Pattanayak 2006). One of the reasons for the slow uptake of monitoring and evaluation programmes in certification is that they are still fairly new concepts. Many forest managers recognise the need to monitor, but are unclear about the best approach: what to measure and how to measure it. In an ideal world, where we had a perfect understanding of how different management interventions affect forest biodiversity, this could be used to dictate a clear code of practice—or certification standard—that would guarantee responsible use (Gardner 2010). Management compliance could be obtained simply by monitoring the implementation of management activities; often termed implementation monitoring. This is not the case, however. The environmental and social consequences of human impacts are unpredictable, many threatening processes remain poorly understood, and in the majority of cases we have a poor understanding of how generic guidelines can be most effectively adapted to fit the context of a specific forest landscape (Gardner 2010). Monitoring is needed to overcome two interrelated problems that are central to the certification process:

- Ensuring that minimum practice standards translate into minimum levels of performance on the ground (often termed 'effectiveness monitoring'). This should be an integral part of the auditing process, and is an essential part of any performance-based standard (e.g. FSC);
- Evaluating the extent to which existing management standards are adequate and how they can be further refined to ensure continued progress towards long-term sustainability goals (often termed 'validation monitoring'). This is essentially the same as applied research. It provides a valuable mechanism for learning how to improve opportunities for biodiversity conservation within the certification process (Gardner 2010).

Within the context of the FSC, most information about the impact of certification is generated through audits of forest management units, i.e. 'effectiveness monitoring'. The FSC refers to this as 'impact monitoring', which they do primarily through the analysis of Corrective Action Requests (CAR) (FSC 2009). Annual reports about each FSC certified forest-management unit describe how forest management has to improve to meet FSC standards, and to gain or maintain certification. Failures to meet FSC standards are described in the certification reports as CARs and are used as indicators of where a change or adaption of management practices is required.

This approach is an indirect method to evaluate the effects of certification processes, based on evaluations by certification bodies. Audits are, however, confidential in detail, and they may not actually provide much information about the long-term social and environmental sustainability of the system (the 'validation monitoring'). Such CAR-based monitoring is focused on progress towards sustainable forest management but cannot determine impact on social and environmental goals, unless supported by more detailed monitoring processes. The FSC plans to address this issue by adding 12 new impact indicators, ranging from ecosystem services and biodiversity, to occupational safety and health (FSC 2011). It is unclear at the moment what these indicators will consist of and how they should be measured.

Certified trade in ecosystem services requires an additional type of monitoring (besides implementation, effectiveness and validation monitoring), which is the measurement of services provided by the forest, in order to translate these into a market price. Such quantification might not necessarily be required for certification (which focuses on the process only), but is needed to facilitate trade. In the case of ecosystem service schemes that directly involve rural communities, the development of locally-relevant monitoring protocols is potentially critical for enhancing adoption and generating trust among providers and beneficiaries. Le Tellier *et al.* (2009) devised a low cost monitoring scheme to test whether upland cloud forest conservation was maintaining dry season river flows in Bolivia. Their study provides valuable insight into the design of participatory approaches to monitoring. As discussed in the introduction, measuring the provision of forest-based services remains difficult, with the possible exception of carbon sequestration. Measuring goods such as NTFPs might be easier but primarily concerns niche markets. The challenge is to develop practical and scientifically sound methods that address the following criteria.

- forest definitions: what qualifies as a forest.
- additionality: what are the actual or prevented changes in quality and quantity of ecosystem services compared to a business-as-usual scenario.
- baseline or reference level: payments for services are based on a baseline, which is the ecosystem system profile in the absence of a planned activity.
- leakage or displacement: to what extent would payment for ecosystem services displace detrimental activities to other locations, and to what extent are opportunity costs of conservation increased elsewhere. This leakage elsewhere might be less of a concern to forest certification if the local conservation priorities are actually met, but it is important for broader markets of ecosystem services such as carbon.
- permanence: how to make sure that services are maintained permanently.

Finally, for certification of ecosystem services to work, such projects have to be economically viable in the first place. In other words, the value of the services obtained from forests needs to be higher than the opportunity costs of foregone development, unless such projects are subsidised as a social good. Deforestation, for all its negative impacts, does also bring many benefits. Timber can be used for construction, and cleared land can be used for crops or as pasture. Similarly, forest degradation because of selective logging, fuel wood collection, or grazing of animals also brings benefits, and avoiding this degradation foregoes these benefits (Pagiola and Bosquet 2009). These opportunity costs are usually the single most important category of costs a country would incur if it reduced its rate of forest loss to secure payments for ecosystem services (Venter *et al.* 2009b). An open market system, in which all economic actors have an equal opportunity of entry in that market, would require that the forest manager understands how the opportunity costs of foregone deforestation develop over time in order to weigh up whether forest protection for ecosystem services remains an economically competitive option. Estimating the magnitude of opportunity costs also gives a fair estimate of the pressures for deforestation (Pagiola and Bosquet 2009), and the investments a forest manager might have to make to counteract those pressures. Monitoring how opportunity costs are distributed across groups within a society also tells the forest manager who would gain or lose from payments for ecosystem services, which is important both

Table 6. Overview of costs involved in certification of an ecosystem services project

Monitoring type	Description	Party most likely to incur costs
Implementation	Monitoring the implementation of management activities	Forest manager, project developer
Effectiveness	Monitoring of minimum levels of performance on the ground	Forest manager, project developer, third party verifier, buyers
Valuation	Measurement of services and goods, baseline, leakage, additionality, and permanence	Forest manager, project developer, third party verifier, buyers, donors, researchers
Validation	Progress towards long-term sustainability goals	Project developer, researchers, donors
Opportunity	Monitoring the foregone benefits from alternative land use scenarios	Project developer, researchers

Source: Various internet sources

from a moral/ethical perspective (if losses would be borne by vulnerable groups) and from a practical one (if losses would be borne by politically powerful groups able to prevent adoption of PES policies or resist their implementation) (Pagiola and Bosquet 2009).

The above examples indicate that monitoring and verification is a complex field requiring considerable investments from those involved in the development of ecosystem service projects. The challenge for any certification programme for forest ecosystem services will be to develop a monitoring process that addresses all the issues of implementation, effectiveness, and validation (with traders also requiring valuation of service and opportunity costs) but without overburdening the forest managers with an unrealistic work load and price tag for monitoring. After all, the higher the cost of monitoring, the less likely it is that certification will be financially attractive to sellers and buyers of ecosystem goods and services. Not all costs are, however, incurred by the forest manager or ecosystem service seller, and other parties such as project developers, donors, third party verifiers, service buyers, and supporting groups such as NGOs and researchers can cover some of these costs (Table 6).

Few forest conservation and sustainable management projects have managed to overcome the challenge of developing monitoring systems in certification that are affordable and provide useful data. Schulze *et al.* (2010) mention that in Brazil, auditors spend too much of their time evaluating indicators that are laborious to measure and associated only with minor forest impacts, taking time that could be spent on indicators related to more severe forest degradation. For example, they often observe auditors who are overly concerned about relatively minor issues such as tree stump height, width of forest roads or size of log loading patios, rather than more fundamental environmental management issues that have a far greater impact.

It has been proposed that local stakeholders be more directly involved in monitoring (de Longh and Persoon 2010; Fry 2010), which could reduce costs (compared to the use of expensive external consultants) and increase stakeholder buy-in and support. Greater economies of scale might also help to reduce costs (Tacconi *et al.* 2003; Engel *et al.* 2008). It would also be worth exploring recent developments such as the spatially explicit modelling tool, Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST). Based on ecological production functions and economic valuation methods, (Nelson *et al.* 2009), this tool allows assessment of synergies and trade-offs between multiple ecosystem services, biodiversity conservation, and market returns to landowners. Such tools could be used predicatively and help set indicator values for various ecosystem services under different scenarios. Examples of ecosystem services and commodity production that InVEST can model include water quality, water provision for irrigation and hydropower, storm peak mitigation, soil conservation, carbon sequestration, pollination, cultural and spiritual values, recreation and tourism, timber and NTFPs, agricultural products, and residential property values.

There are other new modelling developments that might reduce the cost of monitoring and quantification of services. This includes the Soil and Water Assessment Tool (SWAT), a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. It also includes FIESTA (Fog Interception for the Enhancement of Streamflow in Tropical Areas), a spatially detailed decision support tool for managing land use and climate change impacts on water. It helps to guide decisions on where to develop watershed service projects, although it is not yet a stage in which the tool can be used for actual valuation of water. Finally, there is also ARIES, a tool that was funded by the National Science Foundation and developed by the University of Vermont. It is a web-based technology intended to assist rapid ecosystem services (ES) assessment and valuation using an artificial intelligence approach. It will determine optimisation of PES, assess funding mechanisms, facilitate conservation planning and forecasting change in ES provision.

7.3 The role of tenure, jurisdiction over, and regulation of resources relevant to specific ecosystem services

A crucial element in the success of an ecosystem services project is clarity about ownership or tenure of the forests that provide the services. Conflicts over ownership of land or forests often add to loss and degradation of the resources (Dennis *et al.* 2001; Johnson and Forsyth 2002; Pearce *et al.* 2003; Engel and Palmer 2006, 2008), and without solving tenure and ownership issues sustainable forest management is unlikely to succeed. Security of tenure becomes increasingly important when participation in PES programmes requires long-term investments such as reforestation (Wunder *et al.* 2008b). Certification of ecosystem services needs to effectively address tenure and ownership issues to ensure that PES programmes do not lead to resource conflict. In 2002, about 77% of the world's forests were owned by governments. In the 24 countries with the most forest, 2.8 billion ha was owned and administered by governments; 131 million ha was reserved for communities; 246 million ha was owned by indigenous and community groups; and 443 million ha was privately owned by individuals and firms (White and Martin 2002). Between 2002 and 2008, this picture changed considerable, illustrating the broader trends in forest tenure. In those 6 years, the absolute area of public forest land administered by government in 25 of the 30 most-forested countries decreased by 175 million ha, while the absolute area of forest designated for use by communities and indigenous groups in these countries increased from 49 million ha in 2002 (1.5% of the global forest estate) to 76 million ha in 2008 (2.3%). In the same period, the absolute area of forest land owned by individuals and firms in these countries increased from 339 million ha (10.5% of the global forest estate) to 461 million ha (14.2%) (Sunderlin *et al.* 2008).

Private forest ownership is primarily concentrated in temperate forest countries, whereas most tropical forests are government-owned. There are obvious exceptions to this, with communities in Papua New Guinea for example having strong tenure over most forest land. This is relevant for ecosystem service certification, because research suggests that government-led, top-down certification projects are less likely to succeed (Engel *et al.* 2008; Wunder *et al.* 2008b; Bond and Mayers 2010). Wunder *et al.* (2005) summarised key aspects of this issue based on a review of Vietnamese PES schemes. This study indicated that because the national government controls most forest land, no real land-use choice existed. In most sites, little forest land had been allocated to households—and even less for forests that are critical for environmental services. If the state fully owns the land and completely controls land-use choices, the payments are superfluous and ineffective. For PES projects to work at a community level, communities and individual households need to be able to effectively influence land use. Also, payments in forest protection contracts from the state to households typically made up 1%–2% of total household income in Vietnam. Even if the landowner had property rights and a significant degree of land-use choice, the amount offered would normally be insufficient to fully 'compensate' for the opportunity costs of foregone uses.

The above mentioned trends suggest an increased devolution of tenure rights from government to communities and indigenous groups, with legal reforms strengthening community forest tenure in forest countries (White and Martin 2002; Agrawal *et al.* 2008; Sunderlin *et al.* 2008). Initiatives such as REDD+ (reducing emissions from deforestation and forest degradation, and enhancing forest carbon stocks in developing countries) seek to include solutions that address the historical dispossession, political exclusion and cultural marginalisation of indigenous people and members of local communities (Sikor *et al.* 2010). It is likely that potential buyers of certified ecosystem services would want to ensure that the land rights of local forest communities are respected. This is already part of several certification criteria. The FSC Principle 2 on tenure and use rights and responsibilities, for example, requires that 'long-term tenure and use rights to the land and forest resources shall be clearly defined, documented and legally established'. The Climate, Community and Biodiversity Alliance (CCBA) carbon standard also requires that 'there should be no significant land tenure disputes in the project area, or the project should fundamentally help to resolve these tenure issues'. Indicators for this are that the project proponents must:

- guarantee that the project will not encroach uninvited on private property, community property, or government property;
- guarantee that the project does not require the relocation of people or any relocation is 100% voluntary and fundamentally helps resolve land tenure problems in the area;
- describe potential 'in-migration' of people from surrounding areas, if relevant, and explain how the project will respond.

Sikor *et al.* (2010) provide further guidance through three principles: 1) forest people's participation in political decision-making regarding their own affairs; 2) equitable distribution of forest benefits is the second principle; 3) recognition of forest peoples' particular identities, experiences and visions—as many forest peoples see themselves as outside the cultural mainstream and find their own cultures devalued. The problem with these principles is that they might be hard to translate into measurable indicators. To what extent were people allowed to participate in policy making, or is, for example, a 50–50 revenue sharing principle between government and community fair and equitable? Opinions may differ even within particular communities on such questions, making it hard for certifiers or auditors to determine whether conditions are met.

In tropical countries, tenure is often unclear. State governments generally own the forests, but forest communities are granted some tenure rights, or they acquire those rights by default because no one disputes them. However, once commercial interests come into play, for example through timber harvest or PES schemes, the legal issue of who has actual ownership over resources needs to be resolved. With rights slowly shifting from central government to local government and to local communities, the situation often arises in which legal tenure rights are unclear: the government has not officially granted community tenure, but they may have done so unofficially by condoning that communities obtain payments from those that extract resources from forests. For certification purposes, the long- term tenure rights in a particular area must be worked out, which may be partly based on government legislation and partly on customary or perceived rights. For example, if a community has lived in an area for several centuries but the government still owns the land and does not legally recognise community ownership, an ecosystem services certification project somehow needs to weigh in the expectations of those local communities. Such assessments are likely to be value-driven rather than fact driven, and therefore hard to measure and monitor, although they do need to be addressed, as for example required by FSC Principle 3. Certification may in fact help in the clarification of tenure; in Guatemala, FSC certification provided a powerful impetus to convert unofficial to official tenure (Larson *et al.* 2008).

An additional tenure challenge in PES projects could occur when such projects create significant revenues for local communities, thereby attracting immigrants who are looking for a share of those revenues. How do such situations change tenure issues and how can conflicts within communities be avoided? As recommended by CCBA, the least a project can do is to monitor and record immigrants and facilitate solutions that are acceptable to the communities. In addition, if governments do have a role in such projects as a recipient of payments for ecosystem services and/or as regulator, they may require some regulations as to who qualifies for a share of the payments, among original communities and newcomers. Forest managers (communities, companies or government) may require specific legislation about who the beneficiaries of PES schemes should be, with certification of the services requiring adherence to that legislation. Again, it poses certifiers and auditors the challenge of determining who is an immigrant and who is original. It also raises the question of whether that it is an issue that should be addressed by the forest manager.

Issues of tenure, jurisdiction and regulation might be easier to resolve for ecosystem goods or services that are primarily managed by communities and in which government or large companies have no role. For example, certification of forest honey is mostly organised by communities themselves with the help of NGOs; the resources are clearly owned by communities, or at least the government takes little interest in the trade. These goods are often traded through niche markets with quite clearly defined links from forests or forest gardens to markets, and from buyers to intermediaries to cooperatives and individual resource owners for payments. Customary rights to land and produce are in those cases often well respected by all parties and are relatively easier to monitor than in more diffuse ecosystem services such as carbon or water. However, as mentioned above, financial successes in marketing ecosystem goods and services may attract newcomers forcing the sharing of revenues among more people, and thus reducing financial incentives for certification or potentially creating conflict among newcomers and original producers.

Overcoming the challenges of certifying aspects of tenure, jurisdiction and regulation of ecosystem services should at least involve a clear description of the legal and customary aspects of tenure, and some joint agreement between government, industry and communities about tenure and revenue sharing. These are costly processes: for example, a 70 000 ha project in West Kalimantan required US$1 700 000 in project preparation at community level, with tenure issues being a significant component (F. Momberg, personal communication). This again touches on cost considerations: What is required to solve tenure issues? Who pays those costs? Can the costs be absorbed by the ecosystem service project without losing economic viability?

7.4 Regulatory framework

The challenge facing global environmental governance mirrors the recognition in policy science of a shift from government to governance in society's management of social problems (Huitric *et al.* 2009). In general terms, this implies a shift from the democratic state as the primary holder of authority (steering through a bureaucratic system that uses regulative policy instruments and relies on an administrative rationale) to a situation where several groups of actors may claim authority. In this new situation, networks have emerged as an important governance form besides hierarchy, and communicative and market policy instruments are increasingly used, including various forms of public–private partnerships. This slow shift from government to governance is reflected in the shift in forest ownership from central government to local government and communities. Both processes pose particular problems for the development of ecosystem services projects and their certification, and because governance systems are not static, certifiers and auditors need to base their assessments on a constantly changing set of regulatory and customary rules.

Because different sets of governance and regulatory frameworks have an impact on different aspects of ecosystem services systems, this leads to a complex governance system that somehow certification needs to credibly assess and monitor. This system includes regulations and governance that control the supply chain, rights over and claims to ecosystem services, spatial land use planning and planning for local participation, public awareness programs, monitoring requirements, and the rules and regulations that govern the actual payments for ecosystem services (Lebel and Rajesh 2009).

Certification has been promoted to enhance forest management in countries where state governance capacities are insufficient to adequately manage natural resources and enforce pertinent regulations, given that certification relies largely on NGOs and private businesses. In countries with generally weaker governance systems the challenge is to detect and track fraud within any of these areas of regulatory management. This is especially dangerous for ecosystem services that are relatively new on the market, with large financial potential, and few established rules and regulations, such as carbon (Creagh 2010; Vidal 2010). Certification schemes need to ensure that the various regulatory components of ecosystem service projects are transparently assessed, and that a clean bill of regulatory health can be given for projects. This requires monitoring, but unfortunately this is the least well-developed area of governance (Lebel and Rajesh 2009). Monitoring of policies and projects is important to detect incomplete or distorted implementation; assess compliance with agreements, evaluate impact, and learn from the past to improve future interventions.

Certification for governance transparency and effective implementation of rules and regulations should be weighed against the additional complexity this would impose on the certification system. A very strict certification system might be able to detect all fraud or legal inconsistencies in forest ecosystems services programmes, but might be too unwieldy or costly to implement and ultimately fail because of high overhead costs. Still, for credibility purposes misuse of the certification brand needs to be monitored and controlled.

8 Discussion

The purpose of this review was to provide input into the development of pilot projects for ecosystem service certification. There is significant scepticism about the feasibility of certifying ecosystem services. The two most obvious candidates in large-scale projects are water and carbon. At a global and regional scale, carbon sequestration seems the most likely candidate for piloting certification, with other ecosystem services facing a range of methodological and organisational challenges that make certification unlikely in the short to medium term. The main obstacles are limited market opportunities for certification, with too few competing buyers and prohibitive costs. Within niche markets, however, opportunities exist to further expand certification of ecosystem goods, such as non-timber forest products (NTFPs).

The focus of the Forest Stewardship Council (FSC)-Global Environment Facility (GEF) certification programme for ecosystem services is on tropical countries, but these countries have a poor record of accomplishment with FSC certification. Approximately 8% of the global forest area has been certified under a variety of schemes (FAO 2009). Most of this certification, however, is outside the tropics: in Africa, Asia and tropical America less than 2% of the forest area is certified. According to an FSC-GEF project document, the programme targets 'expanding FSC certification at landscape level through incorporating additional eco-system services'. Most certified forests (82%) are large and are managed by the private sector (ITTO 2008), which suggests that private sector partners, working at landscape scale, with opportunities to bundle ecosystem services (e.g. REDD+, timber and NTFPs), might be a good starting point for the proposed pilot projects.

A focus on private sector or industrial forests for certification raises the question whether certification of ecosystem services should target broader socio-economic goals, such as rural development or poverty alleviation. Certification must deal with the new realities of tropical forest landscapes, and it is vital to understand how to make certification worthwhile for community and smallholder producers in landscape mosaics (Zagt *et al.* 2010). Ghazoul (2010) proposes a scheme with various small-scale actors working together in landscapes producing certified timber along with other certified products. Zagt *et al.* (2010) argue that if certification targets only large industrial forestry operations, it will miss the chance to alleviate poverty and conserve biodiversity in those forests that sustain most of the world's remaining biodiversity.

Forest Trends (2008) found 'significant' potential for combined sustainable forestry and agro-forestry certification, particularly following the establishment of voluntary standards, notably the Voluntary Carbon Standard (VCS). Also, payments for ecosystem services (PES) appear to be most relevant when an ecosystem service is under threat in marginal lands where opportunity costs are modest and land claims clear (Wunder 2007). This point was also made by Neef and Thomas (2009) who suggested that given clearly delineated property rights and low transaction costs, payments for environmental services hold the promise to be most effective in halting environmental degradation in sensitive upland areas. This would steer pilot projects towards upland areas or other areas which are less suitable for agro-industrial or silvicultural development, with joint forest management through companies and communities. Also, as suggested by Wunder *et al.* (2005), establishing pilot PES schemes is clearly not an aim in itself—its desirability depends upon the local necessities. They suggest starting on a micro-scale, selecting an applied case with clearly identified environmental-service buyers, a strong land-use linkage to environmental service providers, and choosing a site where a command-and-control approach is not working. If such a pilot project could be successfully established on a small scale, it might create opportunities for scaling up the experience and influencing policies (Wunder *et al.* 2005).The consideration of broader socio-economic goals would steer certification projects towards large landscapes, with well-organised community management, in which various ecosystem services are bundled. This could include community forestry projects, with REDD+ elements, as well as certification of NTFP. Because of the many actors in such programmes, however, the costs are likely to be high. For example, in Indonesia, it was found that REDD is not economically viable at 2 000–3 000 ha, but carbon pools of 10 000–20 000 ha might be (F. Momberg, personal communication). These costs do not yet take into consideration the costs of developing and implementing a working certification system.

One of the reasons why FSC certification has underperformed in tropical forests compared to local standards is that the certification criteria are complex, incurring high costs to forest owners and requiring significant investment in technical support. This raises the question of whether a simple standard should be considered for ecosystem service certification that creates incentives for implementing best practices (such as reduced-impact logging) known to have relatively large biodiversity and forest management benefits instead of complex standards that cover every conceivable impact of forest management and its social and environmental impacts (Zagt *et al.* 2010). The reasoning for such a push to simplify certification criteria is that present schemes do not provide a consistent system for evaluating forest operations and promoting improvement and adoption of forestry best practices. It has been argued that forest certification for timber and fibre has provided an incentive for a segment of the tropical timber industry to reform harvesting practices (Schulze *et al.* 2008). However, in the absence of silvicultural systems addressing sustainability of forest management practices, certifiers have opted for comprehensive standards, criteria and indicators that attempt to address all possible negative consequences of logging (Putz 2004; Sheil *et al.* 2004). This has left unresolved the problem that best-practice forest management for timber in most tropical forests does not represent sustainable use at the species level (Schulze *et al.* 2008). Less expansive but quantifiable and rigorously enforced standards would do a better job of regulating certified operations than comprehensive criteria and indicators that promise much more than can be delivered and thus are largely ignored. Whether the market would accept such standards and create demand remains to be seen, however.

The lesson might be that ecosystem service certification needs simpler sets of criteria and indicators, with monitoring and auditing systems that can be implemented without incurring high costs or regularly requiring expensive outside advice. Greater emphasis on planning and evaluation is more important than endless lists of criteria (Sheil *et al.* 2004). Self-monitoring by communities or other forest managers might also be an option, although this may still require some form of third-party audits to ensure that standards are met. Pilot ecosystem service certification projects should focus on developing broad criteria for environmental and social sustainability, with the requirement that enough criteria are in place to satisfy the monitoring requirements of buyers regarding the quality and quantity of delivered ecosystem services.

One possibility for overcoming the lack of managerial and organisational experience at a local level is to seek partnerships in which companies work closely with local communities to jointly manage certified forests. This could reduce transaction costs, because many providers dispersed over the landscape makes community-based projects logistically complex and companies could function as intermediaries to those paying for ecosystems services (Wunder *et al.* 2008b). A possible working structure is provided by Man and Biosphere Reserves, in which development is balanced through a landscape-level zoning system with sustainable management of natural resources (UNESCO 2010). Schultz *et al.* (2009) conducted a global survey to test the effects of participation and adaptive co-management in the World Network of UNESCO Biosphere Reserves. Analysing survey responses from 146 biosphere reserves in 55 countries, the study found that adaptive co-management was associated with higher levels of self-evaluated effectiveness in achieving development goals, but not at the expense of biodiversity conservation. Local participation seemed to enhance support by local inhabitants, improve integration of conservation and development and have a positive effect on fostering sustainable development (Huitric *et al.* 2009). An example of this is the Giam Siak Kecil-Bukit Batu Biosphere Reserve in Sumatra, Indonesia, in which a fibre company has set aside a peat swamp forest area for biodiversity and carbon offsets, while it develops fibre plantations in a buffer zone, and works closely with communities on rural development in the transition zone (UNESCO 2010). The question is whether such partnerships could overcome core inequality problems. Land grabbing, insecure tenure, overlapping claims, and lack of information on private tenure constitute real medium-term impediments to PES projects. If payments were to accrue to current landholders regardless of current tenure insecurities, large landowners who account for about 80% of all deforestation would reap the highest benefits (Börner *et al.* 2010). Sven Wunder (personal communication) points out that PES schemes are likely to be most relevant where there are substantial externalities, i.e. a substantial proportion of the benefits and the costs of the existing management regime accrue not to the land managers themselves, but to other stakeholders. Ideally the recipient is the chain saw operator, ready to put it to work. Yet because of the complex relationships within a wide range of such stakeholders, there are few generic facts and time-tested solutions.

Zoning of landscapes for development and conservation purposes under an FSC certification framework could be helped significantly by the identification of 'high conservation value forests' (HCVF). This concept has had much stronger uptake than FSC certification itself, and industrial sectors outside timber and fibre (e.g. mining and oil palm) regularly apply the HCVF identification criteria to guide their land-use planning. Identification of HCVFs and guidance on how ecosystem service providers could sustainably manage their high conservation values would provide solid support for the environmental and social sustainability of forest management for ecosystem services. If marketable ecosystem services were guided by HCVFs, this would probably cover many of the social and environmental concerns of ecosystem service buyers. The question would then be, to what extent other certification principles and criteria would have to be incorporated to develop a certification system that has broad support from markets as well as nongovernmental groups, while keeping implementation and transaction costs low enough for providers to remain interested in certification.

For certification to be successful it will need to appeal to a broad audience. This requires strong concepts that are understood by a wide range of people, with or without scientific backgrounds, and with different interests in such matters. Such concepts have been named 'ecological endpoints', which are defined as concrete statements, intuitively expressed and commonly understood, about what matters in nature (Boyd 2007). Ecological endpoints have several broad characteristics. They are purely biophysical. They are concrete, tangible, and measurable, and directly connected to human well-being. They have value because they are effective at bridging the gap between ecological and social spheres and do so in a language that is clear to many stakeholders.

One idea for using the endpoint concept in ecosystem service certification would be to expand the notion of HCVF to include broader 'high conservation and ecosystem service values' (HCESVs) which could provide a measure of the density of these values per area. This would assist in quantification of co-benefits, for example, sequestering a certain volume of carbon dioxide in a forest with a particular HCESV density. This would require incorporating measurements of ecosystem services into the assessment methods for HCESV, for example, by not just establishing that important watershed values are absent or present (HCV criterion 4), but that these contribute a given amount of watershed value, which can be incorporated into the calculation of HCESV density. Recent developments to integrate these different concepts under the RUBICODE program are showing a promising way forward (Harrington *et al.* 2010). RUBICODE is designed to guide prioritisation of conservation efforts in the light of limited resources (Harrison 2010; Harrison *et al.* 2010) and to assist with designing an improved landscape to deliver ecosystem services while mitigating adverse impacts (Samways *et al.* 2010).

The challenge remains to make quantitative links between organism characteristics (e.g., population density) and service delivery to define the unit and allow suitable valuation. This might be possible in well-studied temperate ecosystems, but in tropical forests the lack of ecological information and complexity of the systems might make it hard to make such quantified links. Indicators such as HCV or HCESV might be more feasible but still require that their densities or quantities somehow correlate to the amount of ecosystem service provided. Pilot studies that establish the HCESV density and quantify ecosystem service value in the same area would be helpful to better understand the indicator value that HCESV densities could have for ecosystem service values. If this should prove too difficult or if there is too much variation and noise in the correlation data, another option as proposed by Kontogianni *et al.* (2010) is to set a minimum threshold for the ecosystem or HCESV, below which sustainable ecosystem services can no longer be delivered. This has been referred to as the 'safe minimum standard', defined as '… the minimum quantity of ecosystem structure and process … required to maintain a well-functioning ecosystem capable of supplying services' (Fisher *et al.* 2008). This idea is analogous to the ecological/conservation concept of minimum viable populations, whereby a given population size is considered the bare minimum to ensure the persistence of a species for a suitably long time frame (Kontogianni *et al.* 2010). Such a minimum threshold may have to be dynamic to be able to accommodate changes in markets or socio-cultural values, but this could be done through regular revisions of the threshold value.

Finally, an important issue in considering project choice is the risk of project failure and the longer-term impacts this has on future ecosystem services projects. Bond and Mayers (2010) point out that, in Bolivia, the most recent catchment and water management programmes were top-down and donor-led, with little relevance for the poorer residents of the target catchments. Typically these programmes and projects have failed. As a result a new generation of local programmes let by NGOs are finding it extremely difficult to build confidence and secure participation, especially among poorer stakeholders. The plethora of carbon-focused ecosystem services programmes and the high chance of failure can have significant negative impacts on future opportunities because the major stakeholders lose interest. To prevent this, a few well-designed, locally supported and carefully implemented projects are probably better than the hundreds of superficial trials that are presently being developed.

9 Recommendations and further research needs

This review has highlighted some of the challenges and barriers in developing certification systems for ecosystem services. A range of practical issues have limited the impact of timber and fibre certification on sustainable forest management, especially in the tropics. In addition to overcoming these recognised practical obstacles, a range of other questions need to be studied, either within the context of the proposed Forest Stewardship Council (FSC)-Global Environment Facility (GEF) pilot projects, or as standalone research studies. These include the following:

Do pragmatic and feasible systems for quantifying and monitoring the provision of ecosystem services exist? Is it possible to develop surrogate measures, for example through the concepts of 'service-provider units' or 'ecosystem service providers' (Kremen 2005; Luck *et al.* 2009), or the idea of expanding the concept of 'high conservation value forests' to include a measure for ecosystem services? Could these approaches help to determine the value of the traded service and thus bypass the need to measure the service in a more intensive way?

What drives the demand for certification of ecosystem services? It remains unclear what the most important factor would be in the success of ecosystem service certification. Who is pushing certification, and what role does this play in the ultimate take up of certification in global and national markets? To what extent can demand be modified by increasing understanding and awareness?

Does certification deliver sustainability, or when lacking a clear definition of sustainability, what is the impact of certification on the environmental, social, and economic values of forests? So far, the data suggest that existing certification systems do not result in sustainable management, but simply slow down the loss of environmental and social values. What are the main aspects of forest certification that undermine the long-term sustainability goals and how could these be addressed?

Do the more complex and demanding certification systems achieve better results (relative and absolute) than simpler systems often developed through national initiatives? Would it be better to develop simpler certification systems for ecosystem services that would attract many providers, or more complex ones that would keep the demand limited to a relatively small set of providers who are able or willing to pay the higher transaction costs? Would the consumer be willing to pay for the products certified under simpler systems?

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A major challenge in trading ecosystem services is the need to quantify and commoditise services, for monitoring and verification as well as for trade. This is relatively straightforward for goods such as forest honey or shade-grown coffee, but potentially complex for services such as water purification, reducing risk from floods or other disasters or carbon sequestration.

Developing certification systems for forest ecosystem services is one potential way to define, quantify and verify these services in a way that buyers can trust, and this is why certification of ecosystem services is promoted by a number of environmental and forestry NGOs. Certification of ecosystem services is a useful concept, but many practical and theoretical obstacles must be addressed before it can be put into practice. This paper is a review of existing development in certification of ecosystem services, with information useful for designing and implementing projects to evaluate the efficacy of new systems. We discuss the potential use of more holistic concepts for measuring management sustainability, which are to date undeveloped and untested, and recommend developing pilot projects that are specifically designed to address a number of challenges inherent to ecosystem service certification.

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