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6. Forging ahead: The demand for and delivery of forest ecosystem services

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Challenges of the 21st century

Forests provide a number of goods and services, which are essential for civilizations and crucial for economic development. Forests are also home to at least 80 per cent of terrestrial biodiversity and constitute a major carbon sink regulating global climate. Over 1.6 billion people worldwide depend on forest resources for parts of their livelihoods, e.g. for food, shelter, medicine, and water (Angelsen et al. 2011). Here at the start of the 21st century, the impact of humans on the biosphere is ever more pronounced. Expanding populations and rising living standards increase demands for goods and services from forests, land for farming and grazing, fish and other resources from the sea, minerals from soils and rocks, and fuel from biomass and hydrocarbons. At the 1992 Rio Earth Summit, intense negotiations among governments resulted in an authoritative, but non-legally binding statement of "Principles for Global Consensus on Management, Conservation, and Sustainable Development of All Types of Forests". This declaration affirmed the sovereign rights of states over their natural resources, but also recognised that many aspects of forests and other natural habitats represent ecosystem services of global value and significance. In consequence, broader concepts and criteria of sustainable forest and nature management emerged.

Valuing forest biodiversity and ecosystem services

Since the late 1990s, the number of scientific publications dealing with the concepts of ecosystem functions and the value of their services has increased (Fisher et al. 2009). Particularly two publications, Gretchen Daily's "Nature's services"(Daily 1997) and Costanza et al. (1997) in Nature on "The value of the world's ecosystem services and natural capital", seeded public interest in how ecosystems affect the quality of human life. Costanza et al. estimated the value of the annual supply of services as 50% higher than global GDP.

Critics of these and similar studies have subsequently questioned whether the calculation of the total value of ecosystems makes sense. A more appropriate question, they argue, is to address if we have the right provision of ecosystem services. This redirects the research lens to focus on methods for assessing how the total value of ecosystem services is affected by changes in existing ecosystems (Toman 1998). The Millennium Ecosystem Assessment, MEA, (2005) reinforced this interest by developing and implementing a conceptual framework for assessing the world's ecosystems, ecosystem services, and their impact on people's livelihoods and well-being (MEA 2005; Daily et al. 2011). The main objective of MEA was to assess the consequences of ecosystem change for human living conditions and provide a scientific basis for conservation and sustainable use of ecosystem services. MEA estimated food production to constitute only 3% of global GDP, while perhaps nearly half of the global workforce is employed in the agricultural sector. A study of forest ecosystem services in the Mediterranean area found production values to be less than half of the forest ecosystem services value flows, including carbon storage, recreation, and water (MEA 2005). Approximately 60% of ecosystem services examined had either been heavily influenced by human activities or were subject to unsustainable utilisation (MEA 2005). Despite environmental degradation and a decline in most ecosystem services worldwide, human welfare has increased in the last 50 years (MEA 2005; Raudsepp-Hearne et al. 2010). This does not, however, imply that ecosystems are optimally managed in relation to people's welfare. Many analysts and policy-makers consider the loss of biodiversity and degradation of ecosystem services a global challenge (Sachs et al. 2009) likely to have significant and adverse consequences for future generations and achieving the Sustainable Development Goals.

Livelihoods and forest ecosystem services

As the interest in valuing ecosystem services increased in the 1990s, so did the interest in understanding rural livelihoods in developing countries, including the economic importance of forest ecosystem services in total household incomes. While a string of classic livelihood studies were published throughout the 20th century (Scoones 2015), livelihood perspectives in research and development was only mainstreamed with the Chambers and Conway (1992) working paper operationalizing the sustainable livelihood definition and subsequently the development of the sustainable rural livelihoods framework (Carney 1998) that allowed a structured approach across disciplines and sites. It remained difficult, however, to link quantitatively livelihoods and forest ecosystem services due to the huge number of forest products and services, many of which were challenging to value. William Cavendish (2000, 2002) provided a methodological breakthrough that was further developed and applied across 8000 households in 24 tropical and sub-tropical countries by the international research consortium Poverty Environment Network (Angelsen et al. 2011). These studies showed, among other things, that 28% of total household income derived from environmental products, with 77% coming from forests (Angelsen et al. 2014). This was comparable to crop income, making up an average of 29% of total household income. These advances also allowed studies combining income surveys and biophysical data (Meilby et al. 2014), quantitative analysis of livelihood strategies based on environmentally augmented income data (Nielsen et al. 2013), and the generation of panel data sets that allowed analysis of the role of environmental products in households' movement in and out of poverty (Walelign et al. 2016).

While a set of general challenges to livelihood studies have been identified (Scoones 2015), three areas appear particularly interesting in relation to improving our understanding of the relationships between households and forest ecosystem services: (i) develop the PEN approach so that environmental modules become available in connection to standardized national-level household surveys; (ii) develop the method tool box to allow estimates of environmental resources that are important but typically excluded from household-level valuation studies, such as water; and (iii) initiate studies that move inside the household, e.g. to generate understanding of the relative importance of income from forest ecosystem services to individual household members.

Enhancing the provision of ecosystem services for social gains

The opportunity to supply forest ecosystem services, including protection of production sites, may be influenced at multiple-policy and administrative levels (Dallimer and Strange 2015) by numerous socio-political factors, available budgets, and forest owners' willingness to be involved in the provision of ecosystem services (Barrett et al. 2001; Knight and Cowling 2007). In particular, from a social planner perspective, it is important to improve our understanding of the relationships between forest owner preferences and the spatial distribution of ecosystem services. This will inform the design of regulation and instruments enabling society to target the right forest owners when pursuing changes in ecosystem service provision. An increasing number of studies attempt to reveal forest owners' perceptions of forests, their reasons for owning forests, their willingness to participate in environmental schemes as well as their attitudes towards the contents of such voluntary agreements. These studies demonstrate that forest owners' preferences are highly heterogeneous (Boon et al. 2010). Some owners focus on managing the forest as a timber resource while others are primarily concerned with nature and environmental values. Many owners emphasize the importance of the forest as a place for personal use, leisure time and hunting (Boon et al., 2004). A number of choice experiment surveys in the Nordic countries have revealed forest owners' management objectives, in particular, their views on various forms of ecosystem service provision agreements and contracts. Horne (2006) was the first to study preferences over contract attributes in the Nordic countries and documented that provider and initiator of such contracts mattered for Finnish forest owners when providing enhanced biodiversity protection. Broch et al. (2013) found that Danish farmers are more likely to accept afforestation contracts (and require less compensation) if the objectives of the contracts, e.g. protection of particular ecosystem services, match their own preferences. Additionally, they found that farmers are more likely to accept a contract, and have a lower reservation price if the contract has a time limited exit option, and if they have previously accepted similar contracts. Furthermore, the monitoring policies may affect land owners willingness to accept contracts (Vedel et al. 2015a). Some forest owners may be willing to participate at a lower compensation level for activities they already plan or implement (Vedel et al. 2015b). What is most notable from the above research is the vast heterogeneity in land owners' willingness to accept, and views on, various contract variants. Importantly, the existence of this heterogeneity is not exploited deliberately in standard conservation policies designed to underpin regulation such as the EU Habitat Directive and Natura 2000 forest schemes. Across Europe such measures are mainly focused on offering owners compensations based on direct cost and income foregone measures (Jacobsen et al., 2013), mainly to avoid 'overcompensating' forest owners. Furthermore, the conservation contracts, which land owners are offered, are often modest menus of contracts and designed as equalitarian flat rate schemes in the hope of keeping costs and potential overcompensation at a low level. This is unfortunate for two reasons: This kind of contract does not effectively solve the coordination problem across land owners, as variation in true opportunity costs are not reflected in the way land owners opt into the program or their compensation. From a welfare economic point of view, rents represent a transfer, which may imply some degree of distortionary losses. However, avoiding any sort of rent should not be a social objective in itself. The cost of rents should be balanced against the social cost and benefits of ecosystem service provision (Anthon et al. 2007).

Another approach to regulation is to elicit the owners' true preferences in a reverse auctioning scheme. In a reverse auction, the buyer calls for bids from potential sellers subject to a transparent selection and pricing scheme. This is opposed to a traditional auction where the seller calls for bids from potential buyers. In reverse actions, the social planner asks for bids from private forest owners on their required compensation for providing specified actions to enhance ecosystem services on their land. Such market-based instruments have been advocated for more than two decades, yet only implemented a few times. The available cases, mainly from the US and Australia (Latacz-Lohmanm and Schilizzi, 2005) merely represent pilot experiments. Interestingly, reverse auctions are common in the public procurement of numerous other services (Carter et al. 2004).

Designs of the few existing examples do not meet central criteria to comply with a good auction design, such as transparency about the pricing rule or sufficient competition for the tendered contract types (Latacz-Lohmanm and Schilizzi, 2005; Klemperer 1999). Yet there are positive experiences from existing experiments, which suggests that well-designed reverse auctions do not have greater administrative costs than the existing flat-rate grants schemes (Juutinen and Ollikainen, 2010). We suggest that implementation of further auctioning experiments be improved and advocate for a general change in the design of conservation schemes within the EU.

Forest management for ecosystem services in the Nordic countries – multiple use at what scale?

Thus, in recent years, the research community has made considerable progress in the development of methods for valuing ecosystem services. The number of studies is increasing, also in a Nordic context (Lindhjem 2007). Filyushkina et al. (2015) present a comprehensive review of ecosystem service studies in the Nordic countries and their integration into decision-making models. They find there is a need for (i) wider coverage of non-market ecosystem services and evidence-based modelling of how forest management regimes affect ecosystem services; (ii) improved natural scientific and ecological knowledge of "stock and flows" and the resulting changes in ecosystem services due to changes in environmental policies and initiatives; and (iii) robust economic estimates for the derivative effects and their marginal values (value per unit), and knowledge of how changes in flows affects the marginal values of the service.

Importantly for forest management, the value of the ecosystem services is highly context and scale dependent and varies over time and space. One example is the value of recreational attributes of a forest ecosystem, which clearly depends on their spatial location, in particular proximity to cities and accessibility. Forests located close to cities have a higher recreation value than forests in sparsely populated areas. Other services, e.g. the value of carbon storage, a true global public good, may be less sensitive to the spatial location . Some spatial and management sensitive trade-offs between land uses, e.g. biodiversity and forest management, may indicate that multiple-use forestry – in the sense of pursuing all uses in a supposedly optimal mix on all forest land - as a general concept underpinning modern forest management, is questionable. The management of the multiple services of forests is important but very complex (Bennett et al., 2009). Biodiversity protection may imply very steep or even infeasible trade-offs at the stand or ecosystem level, or require landscape level decisions making a stand or even forest property level optimization an infeasible approach in social planning. Therefore, regulatory design has to consider such spatial and temporal trade-offs to avoid sub-optimization of land use decisions.

Sustainable management and improved decision-making at local scale

Sustainable forest management has for centuries been described as the achievement of meeting Society's future demand for forest products and its benefits. The multi-functionality of forests entails that forestry should not compromise the need for preserving biodiversity, maintaining intact ecosystems, and fulfilling social functions at all spatial and temporal scales (Davis et al., 2001). Sustainable forest and nature management planning are complexity planning. For forest and nature managers, sustainably managing a particular forest or nature area means determining, how management actions ensure sufficient future delivery of ecosystem services from the forest. This implies that forest and nature managers usually must assess and integrate a large number of sometimes conflicting factors. Modern forest and nature planning requires a new framework for understanding planning and policy. Trends of expert driven, and rationality based, decision processes are being replaced by nonlinear, socially constructed processes engaging both experts and stakeholders. This is taking place in countries throughout the world. Trends in appropriate knowledge, where practice expert knowledge is dominant, is replaced by an understanding that knowledge is a social construction and not only experts but lay people possess valid inputs. Therefore, forest and nature managers develop and implement forest action plans in consultation with citizens, businesses, organisations, and other interested parties in and around the areas being managed. Within this complexity of managing forest and nature resources avoiding making biased judgements (Tversky et al., 1974; Kynn, 2008) a value-based focus (as opposed to an alternative based focus) suggests a structured step by step decision framework. The Structured Decision Making (SDM) framework (Gregory et al. 2012) is an organized approach to developing and evaluating creative alternatives and making defensible choices. It has been particularly useful for helping groups work productively together on decisions marked by technical uncertainty and controversial trade-offs. It combines analytical methods from decision analysis with insights into human judgments and behaviour from cognitive psychology, group dynamics, and negotiation theory and practice. The primary purpose of an SDM process is to aid and inform decision makers, rather than to prescribe a preferred solution. Such approaches may provide a sound way to emphasize the quantification of impacts of alternative actions/alternatives on the achievement of objectives in forestry.

Perspectives

The role of forests and their many ecosystem services for social welfare is increasingly recognized, both in the global north and the global south. Safeguarding and enhancing the role of forests for social welfare poses challenges for research in forest policy, economics, and management planning around the world, including the need to change research approaches and develop new methods. This is also an opportunity for forest research communities to reach out and engage with strong non-forest research environments, e.g. in social science areas such as public and regulatory economics, political science, behavioural sciences, but also natural sciences with critical insights into the role of forests, e.g. in the fields of biology and climate science.

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