Forest Biodiversity and Ecosystem Services: Drivers of Change, Responses and Challenges

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Definitions

**Biodiversity** (Convention on Biological Diversity 1992):

- the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part
- includes diversity within species, between species and of ecosystems

**Ecosystem services** (Millennium Ecosystem Assessment 2005):

- the benefits that people obtain from ecosystems
- can be classified into: provisioning, supporting, regulating and cultural services
Relationship between biodiversity and ecosystem services

- Relationship is complex and often poorly understood
- Biodiversity is considered as a mechanism through which services are provided
  - changes in biodiversity may lead to parallel changes in the amount or quality of services provided
  - ecosystem services are more influenced by a particular species composition than by the number of species present
- Biodiversity provides insurance against dramatic ecosystem change and helps maintain stability within systems
- Biological diversity has been continuously changing as long as life has existed
  - today the most important drivers of change are anthropogenic
Major anthropogenic (man-made) drivers changing biodiversity of forests

- Conversion of forests into agricultural land, changes in land use
- Over-exploitation or poor management
- Air pollution leading to climate change and acid rain
- Invasive species
Conversion of natural forest ecosystems to other land cover (1/2)

• The loss of natural forests was 7.3 million ha/year during 2000-2005
• Main drivers of forest loss:
  – agriculture is the main direct human-induced driver
  – major indirect drivers of biodiversity loss include e.g.: economic development and low competitiveness of forest activities in comparison to other land uses, slow administrative procedures to obtain permits for forest use, subsidies to farm inputs or farm product exports, policies that recognise deforestation as land improvement
• Population growth, governance limitations, growing international demand for agricultural products and biofuels, incoherent sector policies and climate change can exacerbate the effects of the drivers
Conversion of natural forest ecosystems to other land cover (2/2)

- Sometimes actions increasing current economic value of the ecosystem may increase vulnerability to future changes
- The loss of biodiversity through forest conversion will decrease the potential for adaptation and maintenance of ecosystem services in the light of projected climate change scenarios
Over-exploitation

annual removals from a population exceed the annual increment of that population

- may result in ecosystem degradation, followed by loss of genetic diversity and extinction of species
- often results from the use of forest for fuelwood and fodder
- can open up the forest to other land uses and form a first step towards forest conversion
- over-exploitation
  - of species with a key role in ecological processes (e.g. seed-disperses, pollinators) can have serious consequences
  - of a single tree species may be harmful in areas with a low tree species diversity, or when harvests shift from one species to the next, once the most attractive have been depleted
Changes in biogeochemical cycles (1/2)

Carbon and other greenhouse gases (GHG)

- The increased CO₂ in the atmosphere may cause changes in regional climate regimes and alter forest vegetation and forest ecosystem functions and services.
- Increased concentration of CO₂ has a fertilisation effect where other growth factors are not limiting.
- Climate change is also expected:
  - to affect local biological diversity, possibly causing an increase in species extinctions.
  - to affect the distribution of ecosystems.
  - to bring about increased frequency and intensity of disturbances.
  - to affect the phenology of many plant species.
Changes in biogeochemical cycles (2/2)

Sulphur and nitrogen

- Burning fossil fuels and volcanic eruptions release sulphur, which reacts with water and oxygen in the atmosphere to form sulphur acid. This may cause acid rain that has negative effects on plants, animals and infrastructure.
- Nitrogen cycle has been largely altered by human activities, with the potential to contribute to acid rain, as well as eutrophication of ecosystems.
  - these have caused changes in species composition, favouring species with a greater tolerance for acid environments.
- Positive fertilisation effects of nutrient-rich rain have increased productivity especially in Europe.
Invasive species

= species that successfully invade an ecosystem where they were previously unknown, causing biological change and/or ecological or economic harm
  – most introductions results from human actions
  – climate change has increased their success

• Invasive species change local ecosystem by e.g. competition with or predation on local species, alteration of ecosystem functioning and even genetic contamination

• Invasions result to e.g. altered community structure, biodiversity, homogenisation of flora/fauna and, ultimately, reduced ecosystem services

• Undisturbed and diverse ecosystems are less prone to invasion than disturbed systems
• Biodiversity management aims to maintain or enhance a variety of ecosystem services
  – biodiversity alone is not a guarantee for provision of abundant ecosystem services
  – needs to contain the right mix of species and structure
  – diversity may enhance capacity to resist and adapt to changes

• To conserve biological diversity an approach that goes beyond relying only on conservation areas is need

• Three important settings:
  – management of protected areas
  – sustainable forest management
  – management of biodiversity in agricultural landscapes
Management of protected areas (1/2)

- **Effectively and efficiently managed** protected areas are the best way for ensuring the maintenance of biological diversity
- Currently only 11.5% of world’s natural vegetation is in protected areas
- In developing regions protected areas often lack adequate management and protection
- Surrounding land uses may have negative effects on the diversity inside protected areas
- Participation of local land owners is important to achieve the protection goals within protected areas as well as on the neighbouring private lands
Management of protected areas (2/2)

- Protected areas help natural systems to adapt to climate change by reducing human-caused stresses on the landscape.
- It is essential to:
  - review the capacity of protected areas to meet both present and future species and ecosystem protection objectives in the light of climate change scenarios.
  - carefully manage landscapes surrounding protected areas and maintain or enhance connectivity through e.g. biological corridors.
- Current protected area networks may not provide the degree of protection needed to conserve habitats having an abundance of particularly sensitive endemic species that have narrow geographic ranges.
Sustainable forest management (SFM)

- SFM has potential to contribute to biodiversity conservation, however globally it has not been extensively implemented.
- Reasons for the lack of adoption of SFM:
  - slow and little-transparent administrative procedures
  - high cost of management combined with low timber prices
  - high opportunity costs
  - poor control of illegal logging activities
  - uncertainty about future forest use rights
  - social conflicts due to overlapping rights
Management of biological diversity within agricultural landscapes

- Biodiversity has an important functional role in sustainable agricultural production
- Conservation of biological diversity is not possible unless the conservation role of the agricultural matrix is recognised
- Boundaries between different landscape classes can be unclear, varying from abrupt to gradual
- Edge effects occur on the boundaries between ecosystems
- Edges can be barriers, impenetrable walls or prefable habitats to different species
Functional roles of forests within the agricultural landscapes

Source habitat for species of agricultural importance
- Pest control: habitat where pest-predators can survive
- Pollinators e.g. bee species live in natural areas

Buffers
- Forests inhibit the movement of agricultural waste products to more sensitive areas, especially aquatic systems
- Mitigation agents: Strategically located forests within landscapes can effectively serve as buffers against e.g. storms and flooding

Barriers
- Forests decrease the movement of agricultural pest species
- Forests act against pollution and noise
Towards a new vision of biodiversity and ecosystem services

- Minimum forest cover level in the large-scale landscape would need to be as high as possible (probably >30%)
- Forests would be distributed over widest range of (forest) ecosystems possible and be in large patches
- Functional connectivity to areas that are likely to recover their forest cover over time should be maintained
- Forests should be strategically placed in agricultural landscapes so that conservation, production and livelihood needs are simultaneously promoted
Institutional challenges in maintaining biodiversity and ecosystem services (1/3)

- International agreements have failed to reduce poverty, to implement widespread sustainable forest management, to halt deforestation or to curb greenhouse gas emissions.
- Different international agreements and conventions show much overlap, even competing each other but fail to integrate their actions.
- Many national and local actions have concentrated on regulating activities within the forest sector, while many of the problems arise from pressures outside that sector.
Institutional challenges in maintaining biodiversity and ecosystem services (2/3)

• Formal forest sector institutions do not seem to have been able to cope with the "ecosystems approach" and to involve a wide group of stakeholders in the management of natural resources

• Challenge is to create platforms at different levels (international, national, local) where different actors are able to
  – discuss natural resources management openly
  – address the most pressing issues
  – recognise a common objectives

• There may be need for government support, subsidies etc. to ensure that public services are also provided on private land
Institutional challenges related to payments for environmental services (PES):

- Difficulties in establishing qualitative links between specific biodiversity and specific level of environmental services → difficult to incorporate biodiversity into PES or market schemes
- Challenges in making PES schemes accessible for those most in need of additional income
- Challenges in communicating information to stakeholders in such a way that they could use it for individual and group decision-making
- PES may not be able to compete with profitable land-use alternatives
Positive approach to forest conservation

... should be built on:

- Combining aspects of willingness to conserve with willingness to pay for further conservation
- Removing administrative barriers to good forest management and protection
- Landscape management
- Intersectoral coordination
- Increased communication between stakeholders
- More research on interactions between biodiversity and ecosystem services