Briefing note

10

Ecosystem-based Adaptation and Forestry

Ecosystem-based Adaptation (EbA) is the utilization of biodiversity and ecosystem services as part of a strategy to aid people in adapting to the adverse effects of climate change. Forests are important ecosystems for adaptation efforts, being home to some 300 million people (United Nations Department of Environmental and Social Affairs [UN DESA] 2011) and most of the planet's terrestrial biodiversity, including plants, fungi, and both vertebrate and invertebrate animals. These organisms form complex ecosystems whose services provide clean air and water, food, timber, and other key resources (see Figure 1), supporting some 1.6 billion livelihoods (UN DESA 2011).

Over millennia, forests have also moderated changes in climate by sequestering carbon and serving as carbon sinks. However, a range of human activities leading to deforestation and forest degradation have eliminated forest ecosystems across vast areas of the planet, releasing large quantities of greenhouse gases into the atmosphere and compounding threats from climate change to forests and the services they provide.

GLOBAL ADAPTATION NETWORK

UN environment programme

Figure 1: Ecosystem services from forests

Ecosystem services of forests

1. Provisioning services
a. Timber/fibre (construction, energy)
b. Food (deer, fruits, herbs, seeds, honey)
c. Chemical and medicinal products
d. Water

2. Supporting services
a. Habitats for fauna and flora (biodiversity)
b. Photosynthesis/primary production
c. Soil formation
d. Nutrient cycling
e. Pollination, seed dispersal

3. Regulating services
a. Carbon storage (above/below ground)
b. Purification of air
c. Purification of water
d. Climate regulation
e. Protection against erosion/avalanches
f. Flood mitigation
g. Protection against coastal erosion and storms

4. Cultural services
a. Recreation/aesthetics
b. Spirituality
c. Education

Adapted from Holzwarth *et al*. (2020)

Among the threats from climate change are increased temperatures, altered precipitation patterns, and greater frequency and intensity of extreme weather events. Specific effects of climate change on forests include modified tree growth and productivity, altered tree health (including increased tree mortality), damage caused by storms and fires, and other disturbances such as pest infestations and changing distributions and compositions of forest species (Yousefpour *et al*. 2017; Sousa-Silva *et al*. 2018). The interaction betwen these climate impacts can cause even greater vulnerability (Seidl *et al*. 2017). Combined with further deforestation and degradation, forest ecosystem services vital for agriculture, climate regulation, and urban water supplies will be severely impacted.

In this context, the *Medium-term Strategy 2022–2025* of the United Nations Environment Programme (UNEP) calls for "enhanced support for ecosystem-based policies and restorative and regenerative practices to reduce habitat fragmentation by agriculture and food systems, extractive industries [including logging], infrastructure and other resource- and nature-intensive value chains". Those ecosystem-based policies and restorative and regenerative practices will ideally seek to protect and nurture forest ecosystems, while still allowing for sustainable harvesting of timber and non-timber forest products and the flow of ecosystem services such as water provisioning, soil building, carbon sequestration and disaster-risk reduction, among many others. This focus, often referred to as "bundling" or "stacking" of forest services, contrasts with conventional approaches that seek to maximize short-term profitability, and often result in monoculture forests (Huuskonen *et al*. 2021), the clear-cutting of forests (Windmuller-Campione *et al*. 2020) and the subsequent widespread degradation of their services.

Forestry Ecosystem-based Adaptation Practices

Several areas of forestry (e.g. agroforestry, agrosilvopastoral systems, silviculture, permaculture food forests) could be considered "ecosystem-based forestry" and can be described collectively as "an approach for managing forest ecosystems, including trees and associated organisms and ecological functions, based on natural models of development". These natural models of development follow principles of "continuity, complexity or diversity, timing, and context", and, in doing so, diversify communities' diets and income sources while reducing their vulnerability to economic, climate, and biological shocks. When used for climate adaptation, such practices are known as forms of EbA. Table 1 below discusses EbA practices applicable to a wide range of forestry operations. They are divided into practices dealing with: (1) environmental or direct hazards, (2) social concerns, and (3) economic impacts stemming from climate change. These practices are a portfolio of approaches that can be used in concert with one another to build resilience in the form of diversified production systems, strong relationships with forest communities and sustainable economies.

©UNEP/Hannah McNeish

Table 1: Forestry EbA practices for environmental, social and economic impacts from climate change

Environmental Impacts (direct hazards)
Water stress, drought and higher temperatures
Improve water infiltration and storage capacity of soils (i.e. more organic matter) and 'retention systems' such as storage lakes, infiltration ditches and contour planting, and *rorak* pits (see Case Study I on page 9).
Ensure diversity of tree ages, species, structure and understorey vegetation using drought-resistant species
Ensure water storage, flow regulation and provisioning via the protection of watersheds, headwaters and water harvesting. (see Case Study I on page 9).
Maintain forested hilltops for humidity collection and water infiltration.
Use windbreaks to avoid desiccation.
Shift in viable species with temperature changes
Use protected areas to conserve vulnerable species and habitats, creating corridors for migration (see Case Study II on page 10).
Assist species' adaptation to new conditions with artificial selection (see Case Study II on page 10).
Encourage controlled grazing, or integrated livestock, or agrosilvopastoral systems (see Case Study I on page 9).
Greater intensity and frequency of storms and flooding
Adjust harvesting rotations to minimize damage from landslides or run-off.
Avoid harvesting in vulnerable areas (see Case Study II on page 10).
Ensure species diversity to promote resilience.
Select wind-resistant species and encourage multistorey canopies.
Improve early warning systems.
Protect river source areas (see Case Study II on page 10).
Maintain forests and vegetation in riparian zones (see Case Study II on page 10).
Maintain organic matter, use cover crops in harvested areas and avoid the use of heavy machinery to prevent soil compaction (see Case Study II on page 10).
Ensure suitable species and vegetation in erosion- and flood-prone areas (contour-strip cropping) and avoid harvesting in these areas.
Improve drainage and erosion control.

Erosion and landslides
Maintain vegetation on steep slopes (see Case Study II on page 10).
Ensure deep and shallow root systems to maintain slope stability, holding soil in place during heavy rains.
Practice contour planting.
Avoid soil disturbance in unstable areas (see Case Study II on page 10).
Fire
Improve early warning systems.
Create fire breaks with fire-resistant trees (Figure 2, see Case Study I on page 9).
Plant fire-tolerant species, mix tree ages and densities and thin vulnerable areas.
Implement careful burn regimes - following natural cycles - to remove excess fuel.
Maintain and restore wetlands, and design water storage structures (ponds) to block fire paths.

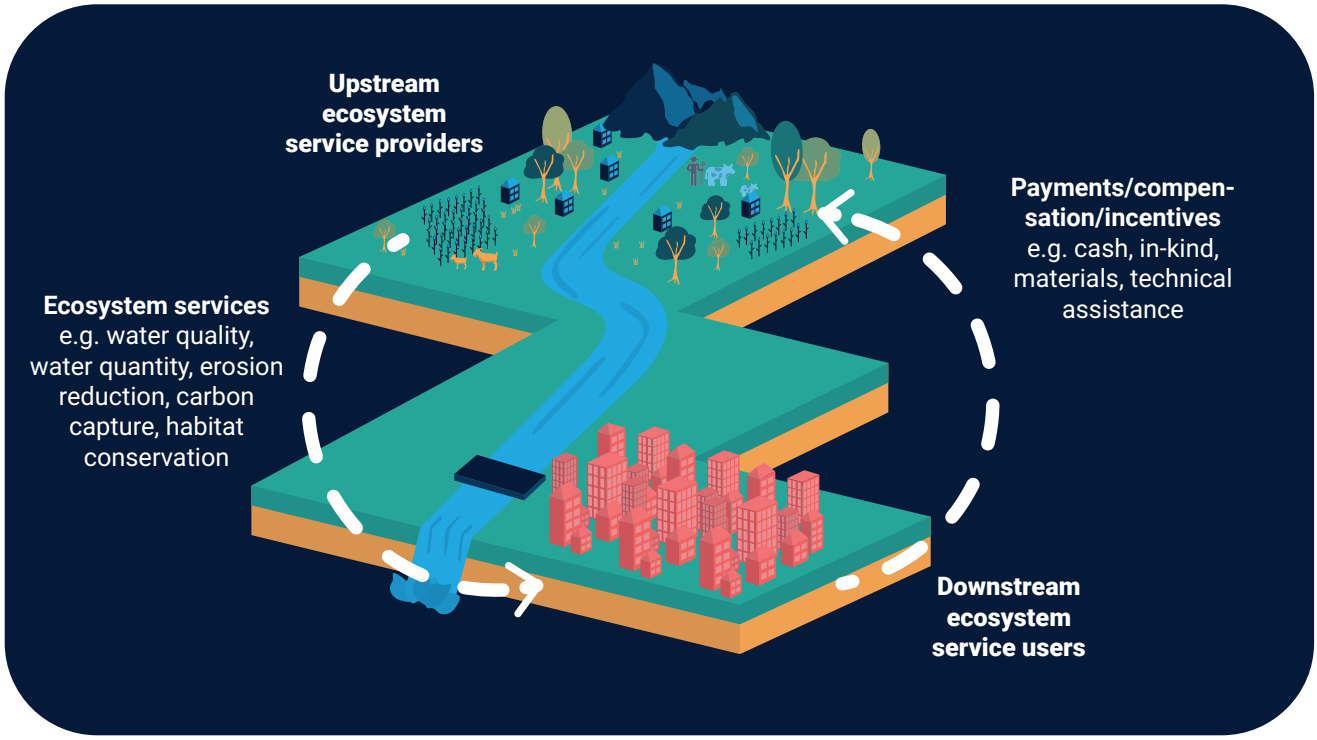
Fire break or belt. ©*Freepik/rafayanes*

Pest and disease outbreaks
Employ integrated pest management.
Combine resilient tree species (agroforestry).

Social Impacts

Climate change may exacerbate existing marginalization, poverty, governance issues and community fragility
Build partnerships to share information on EbA policies and practices to adapt to climate change.
Integrate communities and vulnerable groups into land use plans to meet water, health, energy (i.e. fuelwood sources) and food needs (see Case Study I on page 9).
Develop sustainable livelihoods to increase opportunity costs of illegal forest use while buffering climate impacts on forestry employment (see Case Study I on page 9 and Case Study II on page 10).
Ensure community partipation in management, enforcement and monitoring (see Case Study I on page 9 and Case Study II on page 10).
Strengthen resource tenure (especially of vulnerable groups, including women, indigenous peoples and the poor), while protecting against 'land grabbing' (see Case Study I on page 9 and Case Study II on page 10).

Figure 2: Payments for Ecosystem Services (PES) schemes in forests



Adapted from Lliso (2021)

Economic Impacts

Climate impacts may decrease revenue from forestry activities or make certain forest livelihoods less reliable

Identify new funding sources (e.g. the Landscape Fund) and markets for sustainable non-timber products such as nuts, crafts, honey and medicinal plants (see Case Study I on page 9 and Case Study II on page 10).
Improve supply chain for value added products and premiums from certifications (see Case Study I on page 9 and Case Study II on page 10).
Embrace circular economy principles, using "waste" from production (e.g. sawdust, scrap wood, organic material, effluent) as inputs for energy production, fertilizer and irrigation (see Case Study II on page 10).
Develop payments for ecosystem services (PES) schemes (Figure 3). Forest owners can be paid to conserve forest ecosystems due to the services they provide to downstream communities and society. The most common PES schemes are for water and carbon sequestration.
Explore forestry insurance to promote swift and adequate response to shocks.
Combining forestry operations with ecotourism can often be more profitable in long run (see Case Study II on page 10) (Kirkby *et al*. 2010).

UNEP and partners launched Gambia's largest natural-resource development project in 2017 to help the country adapt to climate change by restoring and protecting ecosystems. ©*UNEP/Hannah McNeish*

Case Studies

©UNEP/Hannah McNeish

Case Study I: Climate Adaptation and Large-scale Land Restoration in the Gambia

One of UNEP's largest climate adaptation projects, aptly titled *Large-scale ecosystem-based adaptation in the Gambia: developing a climate-resilient, natural resource-based economy*, is implementing EbA across 127.88 km^2 of forests, savanna and mangroves, and 30 km^2 of farmland (see the project factsheet for more targets). Using community forest- and community protected area-based approaches, the project engages and integrates communities in planning and designing activities for the sustainable management of natural resources, aiming to restore degraded forests and agricultural landscapes with climate-resilient plant species that provide goods for local consumption or sale, as prioritized by community members themselves, while protecting ecosystems and farms against increasingly severe storm surges and flooding along the Gambia River, in addition to threats from drought and fire.

To manage risk from storm surges and flooding, the project has embarked on a mangrove planting campaign with millions of seedlings to help defend the Gambia River's banks against wave action and erosion, while stopping water from penetrating farther inland where agricultural land is vulnerable to salinization (see the *Coastal Ecosystem-based Adaptation Briefing Note* for more information).

Located in the arid Sahel region, the Gambia is threatened by an expanding Sahara with accompanying drought and increased incidence of fires. Recognizing this threat to lives and livelihoods, the project has established a 150 km-long fire belt with a width of 6–10 m across the country's four regions, wrapping around community forest and farming plots while also relying on active interventions such as the removal of excess fuel, competitor plants (reducing water stress) and lower branches to prevent canopy fires. The presence of Andropogon grass in the region also represents a threat, as the grass outcompetes trees for soil moisture as well as increases fire risk and intensity; therefore, to reduce this threat, the project is supporting the establishment of enterprises for the utilization of Andropogon grass for animal feed in communities surrounding Kiang West National Park.

The project is also facilitating the establishment of natural resource-based businesses (176 in total), reviewed and adopted through a participatory process. This intervention also emphasizes long-term capacity-building in business management, supply chain improvement, and the creation of credit mechanisms to encourage small and medium-sized forest enterprise. Finally, a total of US$ 13.5 million will be raised over 20 years for the National Forest Fund from forest-related taxes and licensing fees.

Challenges facing the project are instructive for other organizations and countries embarking on similar EbA forestry initiatives, and include: (1) multiple factors leading to low seedling survival rates; (2) human drivers of degradation, including bushfires, fuelwood collection and logging; (3) movements of animals and growth of grasses threatening planted areas; and (4) extreme climatic conditions. These challenges have been mitigated by switching to assisted natural regeneration and integrated livestock management, increasing water harvesting (*zai* or *rorak* pits), establishing fire belts around "mother" trees key for regeneration, and creating woodlots for fuelwood supplies. For more information about the lessons emerging from the project, see *Forestry in the Gambia: A climate adaptation case study*.

Large-scale ecosystem-based adaptation and developing a climate-resilient, natural resource-based economy in Gambia.
©UNEP/Hannah McNeish

Case Study II: Community Forest Management in Mexico

Ixtlán de Juárez is a small community located in the mountains north of Oaxaca City, Mexico. After many years during which a logging company operated unsustainably on their land, the community has wrestled back control of their forests and implemented improved forest management practices (gaining Forest Stewardship Council certification) across their communal holdings. These practices consist of patch cuttings with post-harvest cover crops instead of clear-cutting, unharvested high conservation value forest areas (used for high-value ecotourism), riparian area protection, prohibition of harvesting on steep slopes, spring source protection (allowing for a community water bottling enterprise) and assisted evolution of key tree species to different elevations in anticipation of higher temperatures due to climate change. Furthermore, the community has established its own processing facilities to produce value added finished timber products such as chairs, two-by-fours and beds, with further scrap wood and sawdust powering operations. Perhaps most importantly, Ixtlán de Juárez has developed a benefit distribution system, ensuring proceeds go to community members, infrastructure and events, or are reinvested in forestry operations.

Despite being a model for sustainable development and community-based forestry, Ixtlán has seen challenges arise, including corruption and disputes with neighbouring villages. To resolve or mitigate these issues, a community committee has been formed to investigate allegations of corruption, ensuring transparency and accountability in use of funds, while neighbouring villages have been invited to workshops to learn from Ixtlán and benefit from improved forestry practices (Crespo and Biemiller 2018).

Building the climate resilience of Xalapa city, Mexico, through ecosystem-based adaptation. *©UNEP/CityAdapt*

Conclusion

Forests provide a wide variety of ecosystem services vital for our cities, farming, climate system and economy. Given this wide variety of services, forests should be seen as diversified investment portfolios providing opportunities in non-timber forest products, ecotourism, timber, carbon credits from sequestration, payments for water provisioning, and protection against disasters like flooding and landslides, in addition to being home to much of the planet's biodiversity. Smart investors strive to protect their investments against a wide variety of risks. Increasingly severe climate impacts on forests are one such risk, and ecosystem-based practices and adaptation measures are key to ensuring this portfolio remains healthy and balanced well into the future. Promoting the transition to EbA in forestry will require a wide spectrum of practices and policies encompassing forest product consumers, local communities, governments and the private sector, among other key forestry stakeholders. Due to the fact that forests depend to a large extent on what happens in the agricultural sector and the growth of cities, UNEP's *Ecosystem-based Adaptation in Agriculture Briefing Note* and *Urban Ecosystem-based Adaptation Briefing Note* should be explored.

Finally, in line with UNEP's project and programme guidelines, gender equality concerns were taken into account in both case studies of the briefing note. Women and other marginalised groups continue to experience exclusion that limits their ability to fully participate in, contribute to, and benefit from forest initiatives due to the various social, economic and cultural inequalities and legal impediments within the forest sector.

Further resources

- Ecosystem-based Adaptation Briefing Note Series
- Climate adaptation resources and multimedia
- Forestry in the Gambia: A Climate Adaptation Case Study
- UN Decade on Ecosystem Restoration
- Spreading like Wildfire: The Rising Threat of Extraordinary Landscape Fires
- UN-REDD Programme

For more information about UNEP's work on Ecosystem-based Adaptation, contact Jessica.Troni@un.org

References

Convention on Biological Diversity, Food and Agriculture Organization of the United Nations, World Bank, United Nations Environment Programme and United Nations Development Programme (2020). *Biodiversity and the 2030 Agenda for Sustainable Development: Technical Note.* Montreal: Convention on Biological Diversity. https://www.cbd.int/development/doc/biodiversity-2030-agenda-technical-note-en.pdf.

Crespo, O. and Biemiller, N. (2018). The economic benefits of Mexico's community-forest management, 25 June. https://www.conservationfinancenetwork.org/2018/06/25/the-economic-benefits-of-mexicos-community-forest-management. Accessed 28 March 2022.

Crowther, T.W., Glick, H.B., Covey, K.R., Bettigole, C., Maynard, D.S., Thomas, S.M. *et al*. (2015). Mapping tree density at a global scale. *Nature* 525, 201 - 205. https://doi.org/10.1038/nature14967.

Food and Agriculture Organization of the United Nations (2013). Climate change guidelines for forest managers. *FAO Forestry Paper* 172. Rome. https://www.fao.org/3/i3383e/i3383e.pdf.

Holzwarth, S., Thonfeld, F., Abdullahi, S., Asam, S., Da Ponte Canova, E., Gessner, U. *et al*. (2020). Earth observation based monitoring of forests in Germany: a review. *Remote Sensing* 12(21), 3570. https://doi.org/10.3390/rs12213570.

Huuskonen, S., Domisch, T., Finér, L., Hantula, J., Hynynen, J., Matala, J., Miina, J. *et al*. (2021). What is the potential for replacing monocultures with mixed-species stands to enhance ecosystem services in boreal forests in Fennoscandia? *Forest Ecology and Management* 479, 118558. https://doi.org/10.1016/j.foreco.2020.118558.

International Union for the Conservation of Nature (no date). Ecosystem-based approaches to climate change adaptation. https://www.iucn.org/theme/ecosystem-management/our-work/ecosystem-based-approaches-climate-change-adaptation. Accessed 28 March 2022.

Kirkby, C.A., Giudice-Granados, R., Day, B., Turner, K., Velarde-Andrade, L.M., Dueñas-Dueñas, A. *et al.* (2010). The market triumph of ecotourism: an economic investigation of the private and social benefits of competing land uses in the Peruvian Amazon. *PLoS ONE* 5(9), e13015. https://doi.org/10.1371/journal.pone.0013015.

Lliso, B. (2021). Payments for ecosystem services [illustration]. https://commons.wikimedia.org/wiki/File:Payments_for_Ecosystem_Services_(PES).png. Accessed 18 May 2022.

Martini, E., Nguyen T.H., Mercado Jr., A.R., Finlayson, R., Nguyen, T.Q., Catacutan, D.C. *et al*. (2021). *Practitioner's Field Guide: Agroforestry for Climate Resilience*. Nairobi: International Council for Research in Agroforestry. https://apps.worldagroforestry.org/region/sea/publications/detail?pubID=4750.

Seidl, R., Thom, D., Kautz, M., Martin-Benito, D., Peltoniemi, M., Vacchiano, G. *et al.* (2017). Forest disturbances under climate change. *Nature Climate Change* 7(6), 395-402. https://apps.worldagroforestry.org/region/sea/publications/detail?pubID=4750.

Sousa-Silva, R., Verbist, B., Lomba, Â., Valent, P., Suškevičs, M., Picard, O. *et al*. (2018). Adapting forest management to climate change in Europe: linking perceptions to adaptive responses. *Forest Policy and Economics* 90, 22-30. https://doi.org/10.1016/j.forpol.2018.01.004.

Uni ted Nations Environment Programme (2018). In The Gambia, building resilience to a changing climate, 6 February. https://www.unep.org/news-and-stories/story/gambia-building-resilience-changing-climate. Accessed 28 March 2022.

United Nations Department of Environmental and Social Affairs (2011). Forests for people fact sheet. https://www.un.org/esa/forests/wp-content/uploads/bsk-pdf-manager/83_FACT_SHEET_FORESTSANDPEOPLE.PDF.

Windmuller-Campione, M.A., Russell, M.B., Sagor, E., D'Amato, A.W., Ek, A.R., Puettmann, K.J. and Rodman, M.G. (2020). The decline of the clearcut: 26 years of change in silvicultural practices and implications in Minnesota. *Journal of Forestry* 118(3), 244-259. https://doi.org/10.1016/j.foreco.2020.118558.

Yousefpour, R., Augustynczik, A.L. and Hanewinkel, M. (2017). Pertinence of reactive, active, and robust adaptation strategies in forest management under climate change. *Annals of Forest Science* 74(2), 40. https://doi.org/10.1007/s13595-017-0640-3.

Suggested citation: United Nations Environment Programme (2022). *Ecosystem-based Adaption and Forestry*. Nairobi.
https://wedocs.unep.org/handle/20.500.11822/40406