Chapter 5. Opportunities for cost-effective restoration

This chapter outlines the policy context and discusses opportunities for cost-effective ecosystem restoration. It highlights the multiple benefits that restoration can deliver, including climate change mitigation and resilience and inclusive economic growth – and that these benefits can far exceed the costs. The chapter also discusses the essential components for effective restoration, illustrated with short case studies.

5.1. The rationale for ecosystem restoration

Ecosystem restoration, i.e. the "process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (SER, 2004[186]), provides a crucial opportunity to improve the global outlook for biodiversity. Ecosystem restoration can also provide significant societal benefits, through the enhanced provision of ecosystems services such as carbon sequestration, flood regulation, clean air and water. Furthermore, ecosystem restoration can be cost-effective. For example, a recent analysis estimates that restoring 350 million hectares of degraded forest areas globally[1] could generate USD 7-30 of benefits for every dollar invested (Verdone and Seidl, 2017[1]).

Ecosystem restoration is complementary to more traditional conservation approaches for biodiversity. While conservation is important to prevent further declines in biodiversity and ecosystem services, restoration can help bring species back from the brink of extinction and enhance ecosystem services. To be effective, restoration actions must be accompanied by measures to reduce the pressures that led to degradation in the first place.

Restoration can be technically challenging and expensive (although this is not always the case, as for passive restoration). Thus, the conservation of intact ecosystems is a more cost-effective option than restoration to ensure the flow of ecosystems services from a given landscape (IPBES, 2018[2]).

Several multilateral environmental agreements include ecosystem restoration. These include Convention on Biological Diversity (CBD)'s Aichi Biodiversity Targets 14[2] and 15,[3] the Sustainable Development Goals,[4] and the United Nations Convention to Combat Desertification's land degradation neutrality (LDN) Target Setting Programme and LDN Fund. At the United Nations (UN) General Assembly in March 2019, governments declared 2021-30 the UN Decade on Ecosystem Restoration.

Governments have also agreed on ecosystem-specific restoration targets. For example, Target 12 of the Ramsar Convention's Fourth Strategic Plan 2016-2024 focuses on restoring degraded wetlands and prioritises those relevant to biodiversity conservation, disaster-risk reduction, livelihoods and/or climate-change mitigation and adaptation. The United Nations Forum on Forests (Goal 1), the Bonn Challenge and the New York Declaration on Forests all include forest-specific restoration commitments (Box 5.1). Similar commitments for other ecosystems – either terrestrial (e.g. grasslands) or marine (e.g. coral reefs, seagrass beds and kelp forests) – are lacking.

Box 5.1. The Bonn Challenge and the New York Declaration on Forests

Launched in 2011 by the Government of Germany and the International Union for Conservation of Nature (IUCN), and later endorsed and extended by the New York Declaration on Forests at the 2014 UN Climate Summit, the Bonn Challenge is a global multi-stakeholder effort to bring 150 million hectares of the world's deforested and degraded land into restoration by 2020, and 350 million hectares by 2030. The Bonn Challenge supports efforts to deliver on a number of international commitments, including Aichi Target 15, the Paris Agreement and the Rio+20 LDN goal. It is supported by several regional initiatives. These include Initiative 20x20, a country-led effort to bring 20 million hectares of land in Latin America and the Caribbean into restoration by 2020, and AFR100, a similar initiative to bring 100 million hectares of land in Africa into restoration by 2030. As of April 2019, 58 commitments promising restoration on 170.43 million hectares exist globally.

Source: IUCN (2019[3])

5.2. Opportunities for cost-effective restoration

The opportunities for restoration are global. Degradation is occurring across all types of terrestrial, freshwater and marine ecosystems, and in all regions of the world. Estimates of the extent of global degradation vary considerably,[5] but are large. The recent Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report estimates that 75% of world's land surface is degraded (IPBES, 2018[2]). Gibbs and Salmon (2015[4]) estimate that up to 6 billion hectares (20 times the size of France) of land are degraded. Recent work by the Global Restoration Initiative highlights areas where restoration has the potential to improve food security, reduce poverty and mitigate climate change.[6]

Identifying restoration opportunities from an economic perspective requires comparing the costs of restoration with the benefits. Restoration costs include opportunity costs (e.g. foregone revenue from agriculture or timber harvest), capital costs (e.g. planting or fencing), management costs (e.g. monitoring), and transaction costs (e.g. negotiating contracts and organising programmes). Total restoration costs, therefore, vary according to the project's objectives, land use and ownership; the degree of degradation; the type of restoration intervention required; and the timescale for restoration (Bullock et al., 2011[5]; Iftekhar et al., 2016[6]). While there exists a shortage of information on the costs of restoration[7] (De Groot et al., 2013[7]), the available evidence indicates that project costs can range from several hundreds to thousands of US dollars per hectare (USD/ha) for grasslands, rangelands and forests, to several tens of thousands of US dollars for inland waters and millions of USD/ha for coral reefs (Nebhöver, Aronson and Blignaut, 2011[8]).

The potential benefits delivered by a restoration project also vary between ecosystems (according to the type, quantity and quality of ecosystem services they provide), spatially (e.g. according to the location of ecosystem service beneficiaries), and over time. Ecological functioning and ecosystem service delivery may take many decades to fully recover: for example, wetlands have on average 26% lower plant diversity and 23% lower carbon sequestration one century after restoration action than in their pristine state (Moreno-Mateos et al., 2012[9]). Restoration success is also context-specific, with some areas (e.g. tidal and tropical in the case of wetlands) recovering more rapidly than others. The value of the ecosystem services provided by restoration is also highly dependent on the density and number of beneficiaries (Jones et al., 2016[10]). Thus, understanding the spatial and temporal variability of ecosystem-service delivery and consumption is key to assessing the cost-effectiveness of restoration (Birch et al., 2010[11]).

Trade-offs may also exist between different ecosystem services or policy objectives, highlighting the need for clear restoration objectives and a holistic approach to cost-benefit analyses. The Grain to Green Project[8] in China, for example, included the planting of non-native trees on agricultural land to decrease soil erosion, which led to decreased native vegetation cover and increased water use (Cao, Chen and Yu, 2009[12]).

Overall, the available evidence suggests that the benefits of restoration outweigh the costs, particularly when considering the full range of ecosystem service values. For example, de Groot et al. (2013[7]) analysed restoration case studies with information on costs (94 studies) and benefits (225 studies),[9] and integrated the information into a cost-benefit analysis. Benefit-cost ratios were greater than 1 for inland wetlands, tropical forests, temperate forest, woodlands and grassland, and as high as 35 in grasslands. Based on the same dataset, Blignaut et al. (2014[13]) found that the average benefit-cost ratio varies between 0.4 (coral reefs, seagrass meadows and other non-wetland coastal systems) and 110 (coastal wetlands, including mangroves), with the majority of biomes recording an average benefit-cost ratio of 10.

In addition to improving biodiversity outcomes and the provision of ecosystem services, restoration can generate business and job opportunities. In the United States, restoration work is estimated to provide direct employment for 126 000 workers and generate USD 9.5 billion in economic output annually. An additional 95 000 jobs and USD 15 billion in economic input are supported through indirect (business-to-business) linkages and increased household spending (BenDor et al., 2015[14]). The number of jobs created per USD 1million invested in restoration in the United States is estimated to range from 7 jobs for county-level wetland restoration to 40 jobs for national-level forest, land and watershed restoration (BenDor et al., 2015[14]). It is estimated that restoring 15% of degraded ecosystems in the European Union (Target 2 of the EU 2020 Biodiversity Strategy) would result in between 20 000 and 70 000 full-time jobs (Eftec; ECNC; UAntwerp; CEEWEB, 2017[15]).

5.3. Putting restoration into practice

Although countries have established restoration targets under several global initiatives, these vary considerably in their ambition, specificity and consistency. Table 5.1 provides an overview of Group of Seven (G7) country commitments. An analysis of adaptation plans submitted under the Paris Agreement found that 103 plans committed to restoration, management or protection of natural habitats, but these commitments were rarely translated into quantitative targets (Seddon et al., 2018[16]). The post-2020 global biodiversity framework, and the process of updating nationally determined contributions (NDCs) under the United Nations Framework Convention on Climate Change, may provide an opportunity to revisit national restoration targets to improve their specificity and consistency.

Targets and policies for restoration need to account for – and aim to contribute to – a number of policy areas, including biodiversity conservation and sustainable use, climate-change mitigation and adaptation, and food and water security. Although restoration can deliver multiple benefits, governments may need to address some potential trade-offs. Enhancing biodiversity should be a primary consideration for all restoration action, given the importance of diversity for ecosystem productivity (Liang et al., 2016[17]) and resilience (Oliver et al., 2015[18]), and the potential of poorly planned restoration initiatives to harm biodiversity (Ouyang et al., 2016[19]).

As restoration can be technically challenging, it is important to build on previous successes and learn from the challenges that may have hindered the effectiveness of previous projects. Using guidance and standards that ensure good practice for restoration action and facilitate landscape-scale planning of restoration action can help this aim. There are several international guidelines for restoration already. For example, the Restoration Opportunities Assessment Methodology of the IUCN provides detailed guidance on forest landscape restoration, from identifying opportunities to implementing projects.[10] Ensuring standards and guidelines are maintained and updated for national contexts through knowledge hubs, such as *Réseau d'Échanges et de Valorisation en Écologie de la Restauration* in France and *Società Italiana di Restauro Forestale* in Italy, is an important component of cost-effective restoration (Menz, Dixon and Hobbs, 2013[20]).

Restoring an ecosystem may require restrictions on certain activities, changes in production practices or active replanting. To support these actions, governments may need to draw on a mix of policy instruments. No-take marine reserves, for example, have been effective in restoring biomass, the structure and health of food webs, and ecosystem resilience (Sala and Giakoumi, 2018[21]), while providing spillover benefits for fisheries (Halpern, Lester and Kellner, 2010[22]). Further, creating positive incentives for restoration through economic instruments such as taxes, subsidies and payments for ecosystem services is important. Economic policy instruments can ensure the true costs of degradation are appropriately priced into economic activity (e.g. though taxes, fees and charges) or that the value of ecosystems services provided through restoration is channelled back to the stakeholders instigating the restoration.

Table 5.1. National targets for ecosystem restoration in G7 countries

Country	National Biodiversity Strategies and Action Plans	Paris Agreement NDCs	Ramsar		LDN Commitment (UNCCD)	Bonn Challenge
			Priority sites for restoration identified	Restoration effectively implemented		
Canada	2020: Canada's wetlands are conserved or enhanced to sustain their ecosystem services through retention, restoration and management activities	No specific mention	Yes	Yes	No	No
France	2020: Preserve and restore ecosystems and their functioning	EU-wide commitment No specific restoration targets	Partially	Yes	No	No
Germany	2020: National flood-protection programme "Giving back space to our rivers	EU-wide commitment No specific restoration targets	Yes	Yes	No	No
Italy	2020: Restoration mentioned several times, including in reference to agricultural lands; no specific targets	EU-wide commitment No specific restoration targets	No	No	Yes	No
Japan	2020: Restoration mentioned in three targets and four key actions goals, referencing invasive species, ecosystem services, and climate-change adaptation and mitigation	2030: Target of 36Mt-CO2e for removals by land use, through forestry and improved cropland management	Partially	Yes	No	No
United Kingdom	2020: 15% of degraded ecosystems restored (England) 2020: Deliver peatland and wetland habitat restoration around the Lough Neagh Basin "Futurescape" through support for "Rebuilding the Countryside" Programme for 2015/16 (Northern Ireland) 2020: Restore 240 ha of ancient woodland (Northern Ireland) Ecosystems are restored to good health (Scotland)	EU-wide commitment No specific restoration targets	Yes	Yes	No	0.17 million ha (Scotland)
United States	No	No specific mention	Yes	Yes	No	15 million ha by 2020

Note: NDCs: Nationally Determined Contributions; LDN: land degradation neutrality; ha: hectare; Mt: million tonnes; CO_2e: carbon dioxide equivalent. Effectiveness of restoration under Ramsar is self-reported

Source: National biodiversity strategy and action plans retrieved from www.cbd.int/nbsap/targets/default.shtml
NDCs retrieved from www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx
Ramsar National reports to COP13 retrieved from www.ramsar.org/search?f%5B0%5D=type%3Adocument#search-documents
Land degradation neutrality commitments retrieved from www.unccd.int/actions/ldn-target-setting-programme
Bonn Challenge commitments retrieved from www.bonnchallenge.org/commitments

Paradoxically, environmental legal frameworks can impede restoration activity. In France, for example, soils are not considered a component of ecosystems, limiting the scope of restoration action to decontamination for public health and security reasons (Buisson et al., 2017[23]). In Indonesia, the government passed a decree enabling "production forests" designated for logging to also be leased as long-term ecological restoration concessions for conservation, carbon sequestration and other benefits provided by natural forests. Fundamental changes to legal frameworks may be required for effective and equitable restoration.

Broad and inclusive stakeholder participation is an integral part of effective restoration (see Box 5.2). To make informed decisions regarding restoration and its inherent trade-offs, and avoid negative distributional impacts, an understanding of the way local (and in some cases downstream) communities utilise and manage ecosystem services is needed. This is particularly important in developing regions, where a high proportion of people (particularly vulnerable and indigenous communities) rely directly on ecosystem goods for food and fuel (Ding et al., 2018[24]). Further, incorporating local ecological knowledge and indigenous management approaches into restoration plans can ensure projects are both inclusive and effective.

Finally, to demonstrate the cost-effectiveness of restoration, projects should monitor and report not only the ecological results, but also the changes in the flows of ecosystem services. Much of the information currently available is based on the expected flows of services based on theory, often using the pristine ecosystem as a baseline. Better information demonstrating the actual increases in ecosystem services from restoration, particularly at the scale of individual projects and ecosystems, is crucial for influencing land-use decisions (Ding et al., 2018[24]). Many projects either do not report costs at all or report only a portion of the total costs, often failing to report monitoring or transaction costs (Bayraktarov et al., 2016[25]).[11]

Box 5.2. Examples of ecosystem restoration

France: *Green Infrastructure in Nord-Pas-de-Calais*

The Nord-Pas-de-Calais region in northern France is a heavily industrialised region, with extensively degraded ecosystems from pollution, industry and fragmentation in the 19th and 20th centuries. Historic mining activity in the region had resulted in large areas of polluted and degraded soils, which posed a considerable risk to public health. Restoration work began in 2002 and aimed to avoid further degradation, restore natural heritage and improve connectivity between remaining natural vegetation.

Restoration action was part of a larger national programme for green infrastructure and connectivity ("*Trame verte et bleue*") and included a broad long-term commitment to stakeholder engagement. The steering committee comprised representatives from the public, local governments, the private sector and non-governmental organisations. A wide-ranging public information campaign was launched, garnering significant public support for the restoration project. The project cost EUR 9.8 million (euros) and was ecologically successful, with several species returning to the area. Societal benefits included increased green space for recreation and reduced public-health risks from contaminated soils.

United States: *Collaborative Forest Landscape Restoration Program (CFLR)*

Forested land in the United States delivers multiple societal benefits, with an estimated 124 million people relying on water from National Forest System lands alone. The programme aims to encourage collaborative, science-based restoration; support ecological, economic, and social sustainability; and leverage local, national, and private resources. The CFLR supported projects covering 52 000 to 970 000 hectares, equating to USD 5-35 million in lifetime funding. The types of activities supported included reforestation, invasive species removal, infrastructure upgrades (e.g. forest roads), removal of accumulated biomass (to reduce fire risk) and sustainable timber production.

The CFLR was allocated USD 40 million per year from 2010 to 2015; it created (or maintained) an average of 4 360 jobs per year, generating a total local labour income of USD 661 million. From an environmental perspective, the CFLR has facilitated the planting of over 27 000 hectares of forest, treated around 600 000 hectares to reduce the risk of uncharacteristic wildfire and enhanced the wildlife value of over 500 000 hectares.

Japan: *Coral reef restoration, Okinawa*

The coral reefs around Okinawa island in Japan have suffered significant declines in live coral cover since the 1970s, falling as low as 3% in some areas (Kushibaru). This degradation has several causes: mass bleaching events caused by El Niño in 1997 and 1998, over-exploitation of reef fish, increased water turbidity from poorly managed development and predation by crown-of-thorns starfish. Coral reefs surrounding Japan are estimated to provide USD 1 billion per year in tourism benefits alone, and are thus are strong candidate for restoration.

Coral reef restoration in Okinawa has three key components. The first is an extensive process of stakeholder engagement and participation. The second is a major technical programme of artificial reef restoration, involving the cultivation and translocation of corals to sites. While these techniques can be effective, they can also cost well over USD 200 000 per hectare, making them predominately suitable for small, high-value restoration projects with broad public support, as in Okinawa. The final component is a strong, science-based monitoring and research programme that assesses the effectiveness of efforts and continues to develop the more technical elements of the coral reef restoration.

Source: (Eftec; ECNC; UAntwerp; CEEWEB, 2017[15]) (USDA and USFS, 2015[26]) (Omori, 2010[27]) (Bayraktarov et al., 2016[25]) (Spalding et al., 2017[28]) (Foo and Asner, 2019[29])

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Notes

[1] This study assumed the 350 million hectares were distributed evenly across forest biomes globally.

[2] Target 14: by 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

[3] Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks have been enhanced through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate-change mitigation and adaptation, and to combating desertification.

[4] SDG 14 (14.2) and SDG 15 (15.1, 15.2 and 15.3, which includes a specific commitment to land degradation neutrality by 2030).

[5] The multifaceted nature of biodiversity and the wide variety of ecosystems globally mean the definition of degradation is context-specific. Furthermore, different methodologies exist for assessing degradation. Consequently, estimates of the extent of degraded land are highly variable.

[6] For more details see the Atlas of Forest Landscape Restoration Opportunities (WRI, 2014[30]).

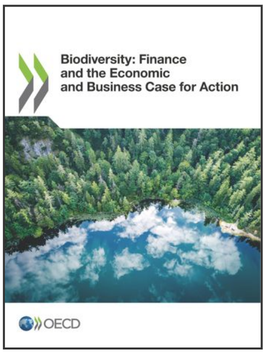
[7] The Economics of Ecosystems and Biodiversity initiative, for example, reviewed over 20 000 restoration case studies and found that only 96 contained useful cost data.

[8] Also known as the Sloping Lands Conservation Programme.

[9] Only direct costs (capital costs and management costs), and known benefits (ecosystem services, not other indirect benefits) were considered.

[10] See also the Ramsar guidelines on restoring wetlands and peatlands; the United Nations Convention to Combat Desertification (UNCCD) database on sustainable land management; and the World Overview of Conservation Approaches and Technologies Global Database on Sustainable Land Management.

[11] This meta-analysis found that only 33% of 954 studies of marine restoration projects reported any cost data at all, and only 10% included some details of both capital and operating costs.



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