POLICY BRIEF

Water flow in the Atlantic Forest, São Paulo, photo: Anna Tengberg

Managing the Forest Water Nexus:

Opportunities for Climate Change Mitigation and Adaptation

The forest and water sectors play key roles in climate change mitigation and adaptation and are important components in the Paris Agreement. Managing for the forest-water nexus generates multiple environmental and socio-economic benefits and is integral to achieving the Sustainable Development Goals (SDGs).

Introduction

In August 2017, the Food and Agriculture Organisation of the United Nations (FAO), International Union for the Conservation of Nature (IUCN), and the Stockholm International Water Institute (SIWI) established an expert group from the forestry and water sectors to identify common ground, and to enhance the attention to the important role played by the forest-water nexus in securing resilient landscapes. The expert group, the Forest-Water Champions (FWC), meets annually to build on its convergence of perspectives and ideas and to implement them through engagement in international processes.

Forests and water are inextricably linked through their multiple functions, including regulation of basin flow, reduction of flooding and droughts, or impact on water yield or quality, as well as climate regulation through carbon sequestration and securing of carbon sinks. The complexity of the highly contextual forest-water relationships requires management decisions that are based on science and an understanding of these relationships at different temporal and spatial scales, as well as changing climate and land-use contexts. There are still knowledge gaps regarding the factors that regulate the multiple functions of the forest-water nexus, their interactions, and ultimately their effects on those that rely on them for water. At its meeting in August 2019 in connection with World Water Week (WWW), the FWC focused on the role of the forest-water nexus in climate change mitigation and adaptation. Below, our main recommendations are presented together with supporting evidence from forest-water initiatives, tools, and approaches used around the world.

Recommendations

Forests and Water – Managing the Nexus for Climate Change Mitigation and Adaptation

1. Managing for the forest-water nexus, is integral to achieving both the Paris Agreement and the SDGs (e.g. SDGs 2, 6, 13 and 15) and should be acknowledged in the implementation of the (Intended) Nationally Determined Contributions ((I)NDCs) and other national commitments related to climate change and sustainable development.

In preparation of the FWC workshop at WWW in 2019, nine (I)NDC reviews were analysed. Most of the reviews focused on issues related to either forest or water. In general, there is a sectoral division between forest and water. There are nevertheless some good examples of **forest-water nexus synergies** featured in the **(I)NDCs**, related to carbon sequestration, sustainable forest management, afforestation/reforestation, restoration, agroforestry, preserving groundwater, watershed management, and risk management (floods, weather and water variability), from countries such as Burkina Faso, Ethiopia, Costa Rica, Mexico, and Seychelles. A recent publication found that 45 percent of (I)NDCs include references to the forest-water nexus https://www.mdpi.com/1999-4907/10/10/915/htm.

There is a major opportunity to scale up nature-based solutions (NbS) in a range of carbon-rich ecosystems in addition to forests. Actions and targets for NbS for climate change mitigation currently mainly refer to the management, restoration, and/or protection of forests and/or afforestation. Meanwhile, grasslands, drylands, coastal, and/or marine ecosystems (e.g. man-

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SDG	Targets	Indicators
	**6.1** By 2030, achieve universal and equitable access to safe and affordable drinking water for all	**6.1.1** Proportion of population using safely managed drinking water services
	6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	**6.5.1** Degree of integrated water resources management implementation (0–100) **6.5.2** Proportion of transboundary basin area with an operational arrangement for water cooperation
	6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	**6.6.1** Change in the extent of water-related ecosystems over time
	**13.1** Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	**13.1.3** Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies **13.1.1** Number of deaths, missing persons and persons affected by disaster per 100,000 people **13.1.2** Number of countries with national and local disaster risk reduction strategies
	13.2 Integrate climate change measures into national policies, strategies and planning	**13.2.1** Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
	**15.1** By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands	**15.1.1** Forest area as a proportion of total land area **15.1.2** Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type
	15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	**15.2.1** Progress towards sustainable forest management
	15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	**15.3.1** Proportion of land that is degraded over total land area
	15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development	**15.4.1** Coverage by protected areas of important sites for mountain biodiversity **15.4.2** Mountain Green Cover Index
	15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts	**15.9.1** Progress towards national targets established in accordance with Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011–2020

Table 1. A selection of Sustainable Development Goals and Targets with key relevance to the forest-water nexus. (https://www.unfpa.org/sites/default/files/resource-pdf/Resolution_A_RES_70_1_EN.pdf)

groves) and other wetlands (e.g. peatlands) are relatively poorly represented. For example, only 19% of NDCs from countries with coastal ecosystems refer to them for mitigation purposes (https://portals.iucn.org/library/node/48525). Addressing the forest-water nexus can thus help generate multiple benefits across many SDGs and for climate change mitigation and adaptation. Contributions to SDG 2 on Food Security, SDG 6 on Clean Water and Sanitation, SDG 13 on Climate Action and SDG 15 on Life on Land are considered particularly important.

A study by the World Resources Institute (WRI) about Natural Infrastructure in São Paulo's Water System shows that **healthy forests act as a natural infrastructure** by filtering water and buffering against impacts of floods and droughts. It finds that restoring 4,000 hectares of Atlantic forest can reduce soil erosion significantly, reducing sediment management costs. In addition, the restored forest can increase dry season water flow and may even increase annual water supply. (https://www.wri.org/publication/natural-infrastructure-sao-paulo).

Moreover, World Agroforestry (ICRAF) found that NbS, such as natural wetlands, improvements in soil moisture retention, and more efficient recharge of groundwater, are important for sustainably managing **water availability** through maintaining or enhancing water storage. Similarly, forests, wetlands and grasslands, as well as croplands, when managed properly, play significant roles in regulating water quality by reducing sediment loadings, capturing and retaining pollutants, and recycling nutrients. Ecosystem degradation is the major cause of increasing **water-related risks** (e.g. floods and droughts). NbS for enhancing water security across all aspects aim for multiplying the benefits from landscapes (https://old.worldagroforestry.org/downloads/Publications/PDFS/BC19024.pdf).

Improved management of water in peatlands can contribute to the **mitigation of climate change**. According to the Global Peatlands Initiative, which conducts activities within four initial partner countries: Indonesia, Peru, Democratic Republic of Congo and the Republic of Congo; the current greenhouse gas emissions from drained or burned peatlands is estimated to amount to, up to five percent of the global carbon budget – in the range of two billion tonnes CO_2 per year. Although there has not been a detailed or comprehensive global assessment, it can be stated with confidence that **improved management of peatlands – reducing their drainage and degradation** – can be achieved with available tools and measures. (https://www.globalpeatlands.org/)

2. The forest-water nexus must be managed at multiple spatial and temporal scales, addressing human well-being, resilience, and climate change. The resulting multi-purpose and functional landscapes need to be supported by comprehensive monitoring frameworks that include water in national forest monitoring and incorporate natural forests as sources of water supply.

At the highest scale, **trees and forests link local to regional and global water cycles** through their modification of infiltration, water use, hydraulic redistribution of soil water, and their roles in precipitation recycling. In other words, to increase water yields it may be best to convince land users in adjacent watersheds and landscapes to increase tree cover. The increased tree

cover may increase rainfall, without the additional water use by trees affecting flow in the watershed. (https://old.worldagroforestry.org/downloads/Publications/PDFS/BC19024.pdf).

However, managing the interactions between forests, water, and landscapes is complex, and practical tools and approaches for monitoring the forest-water nexus and best practices are needed. **The Restoration Opportunities Assessment Methodology (ROAM)** is a framework for countries to rapidly identify and analyse forest landscape restoration (FLR) potential and locate specific areas of opportunity at national and sub-national level (https://www.iucn.org/content/roam-around-world). The guiding principles of FLR include a focus on landscapes, functionality, multiple benefits, stakeholder participation, and adaptive management. ROAM has been applied in a number of countries. In Rwanda it was concluded that realizing Rwanda's significant restoration potential requires a concerted effort to institutionalize restoration at the Provincial, District, Sector, and Cell levels. Market barriers also need to be overcome. Extension services could ensure that investments in restoration benefit farmers and giving them an incentive to maintain the trees once they are planted. All of this also requires investments in education and outreach to communicate the value of restoration. (https://cmsdata.iucn.org/downloads/roar_web_version.pdf).

The FAO **Forest and Landscape Water-related Ecosystem Services (FL-WES) Tool** to improve national forest monitoring systems allows for monitoring the effects of change in land use management on water. It also provides technical assistance, knowledge management, and capacity development to technicians, practitioners, and policymakers. The indicator framework is based on calls for improved understanding of different water ecosystems, scales of water management, and climate scenarios. The tool includes six indicators: three biophysical and thee socio-economic. It currently includes more than 150 methodologies to monitor and evaluate water-forest interlinkages. www.fao.org/2/ForestsAndWater.

The **Blue Targeting Tool** is a practical tool for addressing water in forest management plans, including sustainable tree harvesting in/near riparian zones. Target areas within the tool are biodiversity, water quality, and water availability of riparian zones. The tool takes into account the heterogeneity of riparian ecosystems and highlights conservation values, sensitivity of soil, and added value through recreation. The tool can be used for upstream and downstream exchanges in data to gain an accurate picture of the status and quality of the watershed/river basin. The tool is extensively used by the Swedish Forest Owners Association and the Swedish Forest Agency with over 100,000 users. It has also been adapted to conditions in the Baltic region, as well as in Brazil by the University of São Paulo to fit tropical forests with a higher biodiversity. The tool has been used to restore buffer zones in deforested areas and has proven useful in identifying the riparian zones that are most suitable for restoration from an ecological perspective. (https://www.skogsstyrelsen.se/globalassets/projektwebbplatser/wambaf/blue-targeting/blue-targeting-manual.pdf)

3. There is a need to develop institutions, financial mechanisms, business models, and technical working groups that foster collaboration on forest-water management and include the various stakeholders within the landscape. This would link management of upstream forests and water towers with downstream agricultural and coastal ecosystems.

Water Funds provide frameworks that design and enhance **financial and governance mechanisms** which unite public, private, and civil society stakeholders around a common goal to contribute to water security through nature-based solutions and sustainable watershed management. The Water Funds toolbox (https://waterfundstoolbox.org/getting-started/what-is-a-water-fund) promotes increased investments in water protection and cleaning. The Nature Conservancy (TNC) has assisted Kenya in establishing a water fund to secure the water supply to Nairobi (https://www.nature.org/content/dam/tnc/nature/en/documents/Nairobi-Water-Fund-Business-Case_FINAL.pdf). In Kenya, cities have expanded their water treatment plans at large costs to the cities. However, these costs can be reduced. Managing watersheds is an effective approach to reduce costs and to restore watersheds through improving water quality and water retention. Managing source watersheds is also one of the biggest opportunities to absorb carbon and it could also have positive impacts on hydropower, sanitation, and food security.

The Model Forest Network includes 61 forests in 38 countries and can be described as a large-scale landscape encompassing many different land uses, and a specific partnership-based approach to sustainable forest management. A **Model Forest** is a fully functional landscape of forests, farms, protected areas, rivers, and towns, designed to occupy the middle ground between policy and practice (https://imfn.net/about/). The starting point for the Helge Å (River) Model Forest in Sweden was the increasing problems with brownification and flooding along the river caused by changes in land use. Problems that originated in the upper part of the river basin had negative impacts in the lower part of the basin. Three organizations came together to find a solution: the economic forest owner's association Södra; the Biosphere Reserve Vattenriket; and the Swedish Forest Agency. The Helge Å Model Forest is now organized as a non-profit organization that represents a wide range of stakeholders (https://www.siwi.org/publications/water-for-productive-and-multifunctional-landscapes/) .

Established in 2012, the Kenya Water Towers Agency aims to coordinate and oversee the sustainable management of all critical sources of water, or water towers, in Kenya, taking an integrated ecosystem approach, bringing on board institutions, communities, development partners, and all relevant stakeholders (https://watertowers.go.ke/). The Agency endeavours

Water harvesting in the Upper Tana-Nairobi Water Fund area, photo: Anna Tengberg

to secure catchment lands, wetlands, and critical biodiversity hotspots within water tower ecosystems through gazettement, as well as providing **strong institutional mechanisms** required to facilitate high-level coordination to support these interventions. In this sense, the development of legal mechanisms to better manage the water towers is paramount. In Mau Forest, over 24,780 ha of catchment land were recovered, 97 km of riparian reserves were restored, and the incidence of illegal activities reduced by 80 percent. Interventions have also supported the restoration of important rivers including Sondu, Mara, Moro, and Njoro. As a result, hydropower generation in Sondu-Miriu plant has improved, since more water became available to generate electricity.

4. Strengthened communication, awareness raising and capacity building on the forest-water nexus should be an integral part of all the above.

Capacity development in the forest-water nexus is required, to ensure that we apply our knowledge to better manage forests and trees for their multiple benefits, including water quantity, quality, regulation, and the associated socio-economic benefits on which people within and outside forests so heavily depend on. In this context, FAO's Forest and Water Programme is promoting a capacity development programme, whose overall objective is to improve the management of forests and trees for the provision of water-related ecosystem services.

As a result of **capacity building efforts** during 2017/2018 in India and Ethiopia using the FAO Facilitation Guide for Advancing the Forest-Water Nexus (http://www.fao.org/3/ca6483en/CA6483EN.pdf), the monitoring of forest-water relationships has been integrated into project management plans. Additionally, in India, WeForest has been able to launch an applied science project to investigate the impact of restoration efforts on water availability. This ongoing research is possible because the project team in Khasi Hills received training (theory and practical) during three capacity building workshops over a period of two years. This has enabled them to conduct field work to collect the necessary data on soil water infiltration. The team can now complete this work autonomously with minimal external support.

In Ethiopia the capacity building workshop in 2018 followed a 'Train-the-Trainer' approach and focused on training technical participants from a range of organizations. As indicated by the following quote, after one year, the workshop has already made an impact to the work of some of the organizations:

> *The knowledge and skill obtained from the workshop are integrated in my research and class activities. The ideas also transferred in workshops and seminars. 'Water resource management' course in the undergraduate program restructured to include one chapter on Forest-water interaction. Materials provided in the workshop were used as references.*
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> Fiseha Gebru Gebremedhin, Dryland Water Management Program Coordinator & Lecturer in the Department of Land Resources Management and Environmental Protection, Mekelle University, Ethiopia.

FAO has also been engaged in **awareness-raising at the global level** since 1947 through the Unasylva journal of forestry and forest industries that is published in English, French, and Spanish editions (http://www.fao.org/forestry/unasylva/en/). Its goal is to bring globally significant developments in forestry to a broad range of readers, such as policy makers, forest managers, technicians, researchers, students, and teachers. Over the years, the emphasis has changed from wood production and wood technology to sustainability concepts and awareness of the social role of forestry. This year the edition features Forests and Landscapes as Nature-based Solutions for Water.

Forest-water nexus "train-the-trainer" workshop in Ethiopia, photo: Elaine Springgay

Sendoff

These recommendations result from meetings with forest and water experts, co-organized by FAO, IUCN and SIWI, with contributions from Adam Wei, IUFRO, Anna Tengberg, Lund University/SIWI, Elaine Springgay, FAO, Ingrid Timboe, AGWA, James Dalton, IUCN, Liz Mullin-Bernhardt, UNEP, Lotta Samuelson, SIWI, Malin Gustafsson, SIWI, Maria Carreno Lindelien, IUCN, Meine van Noordwijk, CGIAR, Nathanial Matthews, Global Resilience Partnership, Susanne Ozment, WRI.

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