

Chapter 8

Forest, Trees and Water on a Changing Planet: How Contemporary Science Can Inform Policy and Practice

Coordinating lead authors: Irena F. Creed and Meine van Noordwijk

Lead authors: Emma Archer, Marius Claassen, David Ellison, Julia A. Jones, Steven G. McNulty, Bhaskar Vira and Xiaohua (Adam) Wei

Trees and people both need water. With a growing global population and continued forest loss and degradation – a key question becomes: are trees and people competitors or friends? The relationship between forests, trees and water is an issue of considerable complexity and uncertainty, but of high priority for both people and the environment. In the face of such challenges, the next generation of policymakers and decision-makers will have to consider climate-forest-water-people interactions in a more holistic way. Water may be the key to unlocking policies that flow from a local understanding to actions at global scales.

In the forestry community, it is still largely assumed that only forest authorities are in a position to provide the water required by society. Yet, the combined effects of climate change and climatic variability, modification of forests and increasing demand for water suggest that more explicit attention should be directed at managing trade-offs between forests, water and people. Managing these trade-offs is particularly important in multifunctional landscapes that include forests and trees.

This GFEP assessment focused on three key questions:

1. *“Do forests matter?”*: To what degree, where and for whom, is the ongoing change in forests and trees outside forests increasing (or decreasing) human vulnerability by exacerbating (or alleviating) the negative effects of climate variability and change on water resources?
2. *“Who is responsible and what should be done?”*: What can national and international governance systems and co-investment in global commitments do in response to changes in water security?

3. *“How can progress be made and measured?”*: How can the UN SDG framework of Agenda 2030 be used to increase the coherence and coordination of national responses in relation to forests and water across sectors and from local to national and international scales?

This report provides a global assessment based on relevant scientific evidence and established and emerging scientific concepts. There has been substantial progress in the past decade in the understanding of more narrowly delineated subsystems within the forest-water system. However, the GFEP Panel on Forests and Water recognised that comprehensive answers to the above three questions would vary depending on the region of focus and involvement of regional stakeholders and would require time and resources well beyond the scope of this report.

Our conclusions and their implications (Table 8.1) are intended to inform relevant international policy processes such as the 2030 Agenda for Sustainable Development and related SDGs. The Bowtie Risk Management Assessment Tool inspired the structure of this GFEP assessment report – with individual steps that linked: 1) determinants of change in the forest-water relationship, and drivers of forest and land use change (Chapter 3) to 2) pressures on ecosystem structure and 3) changes in ecosystem functions (Chapter 4), which 4) affect ecosystem services and the people benefitting from them, now and in the future (Chapter 5), 5) leading to a range of prevention controls to reduce pressures or mitigation controls to reduce or adapt to impacts (Chapters 6 and 7).

In Figure 8.1 we link the conclusions and implications back to these individual steps.

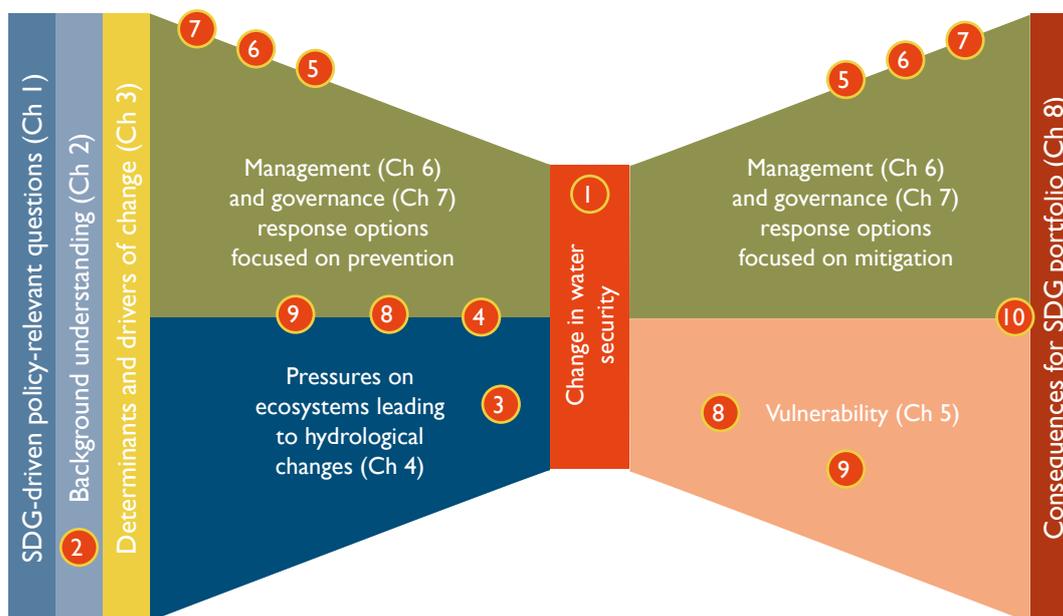
Conclusions and their implications for decision-makers

Table
8.1

Conclusions	Implications
1. Water is central to all 17 SDGs and ambitions.	Governments and other stakeholders that want to achieve the SDGs need to understand the centrality of water and its relations with social, environmental and economic outcomes. Increasingly, it is recognised that SDGs cannot be dealt with individually.
2. A systems approach to climate-forest-water-people relations that integrates hydrological processes and their interactions at all scales is needed.	Limited public understanding of complex ecosystem interactions prevents rational decision-making and can lead to unintended consequences.
3. Forests, especially natural forests, contribute to the resilience of water supply for humans in the face of global change.	Investments in the preservation of existing native forests are needed as part of a multiple disaster prevention strategy, as well as to improve resilience in the face of increasing risk.
4. Forests can be managed for resilience of water supplies to enable adaptation to change if locally relevant data and resources are available.	Investments in data collection and interpretation are essential to support evidence-based risk management planning and adaptation.
5. Multiple water-related objectives across the portfolio of SDGs present new challenges for policymakers and managers of forests and landscapes with partial tree cover.	New institutional responses are needed to tackle multiple water-related objectives across the portfolio of SDGs, taking a multiple benefits approach.
6. International and regional institutional and governance frameworks can play a key role in optimising climate-forest-water management.	New or improved levels of collective action and coordination are needed, including those that coordinate across sectors and across spatial scales.
7. A clear policy gap in climate-forest-water relations exists, waiting to be filled.	Forest-water relations deserve at least as much policy attention, from local to global scales, as forest-carbon relations.
8. Regulations and rights-based approaches to climate-forest-water relations provide an essential foundation for innovation in forest-water governance.	Incentive-based mechanisms present opportunities for coordination of interests and concerns in climate-forest-water management but must respect the rights of local, indigenous and other vulnerable communities.
9. To successfully achieve SDGs, social and environmental justice, along with equity targets, must be integrated into climate-forest-water policies and management strategies.	Already marginalised and vulnerable communities should not be exposed to further risks; opportunities to improve community health and well-being need to be explored when developing forest-water adaptive management strategies.
10. The global nature of the current assessment limited the scope to be quantitative and geographically explicit.	More quantitative regional-scale case studies that include atmospheric relations, surface and groundwater flows are needed that can be extrapolated to other areas with different social and economic conditions.

The ten concluding points mapped onto the Bowtie Risk Management Assessment Tool used in structuring this GFEP report

Figure 8.1



Source: Authors' own elaboration

1. Water is central to all 17 SDGs and ambitions. Governments and other stakeholders that want to achieve SDGs need to understand the centrality of water and its relations with social, environmental and economic outcomes. Increasingly, it is recognised that SDGs cannot be dealt with individually.

Water is central to the United Nations' (UN) 17 Sustainable Development Goals (SDGs) and to global prosperity as a whole. Eight SDGs require an increased supply of safe, secure and reliable water. Six SDGs address social justice and equity, and their attainment will reduce injustice and inequity in access to forests and water. The remaining three SDGs build and maintain an ecological infrastructure that support the other 14 SDGs by adapting to climate change and securing the integrity of the terrestrial and aquatic parts of the planetary system. It is increasingly clear that the SDGs cannot be dealt with individually. Instead, a multiple benefits approach is necessary, and this is particularly important in climate-forest-water-people interactions that comprise the focus of this assessment.

Water scarcity will inevitably increase in the future, as climate variability and change generate uncertainties in water supply, while a growing human population increases demand for water. Forests and forested landscapes regulate the provision of water and water-related ecosystem services. The majority of the estimated four billion people facing insufficient access to clean water live in areas with low forest cover, and most of them

depend on engineered infrastructure that redistributes water across watershed boundaries. Preservation of existing native forests and better-informed management of planted forests, are especially critical in areas with low forest and tree cover. Effective decision-making mechanisms that help to resolve transboundary water conflict and promote shared benefits of water-sharing are necessary.

2. A systems approach to climate-forest-water-people relations that integrates hydrological processes and their interactions at all scales is needed. Limited public understanding of complex ecosystem interactions prevents rational decision-making and can lead to unintended consequences.

A century of science has taught us that forests process water and this water becomes a source for people downstream. Governments and other stakeholders need to work together on global water governance to promote resilient and reliable upstream-downstream and upwind-downwind water supplies. Water is a local as well as a global resource and changing water supplies have cascading effects that no longer respect political and national boundaries. Climate change and climatic variability increase the hydrological uncertainty of the delivery of forest-water related ecosystem services, and, hence, the realisation and distribution of benefits that people derive from them.

3. Forests, especially natural forests, contribute to the resilience of water supply for humans in the face of global change. Investments in the preservation of existing native forests are needed as part of a multiple disaster prevention strategy, as well as to improve resilience in the face of increasing risk.

Natural forests improve resilience of water supply in the face of disturbance and climate change and climatic variability. Changes – both natural and anthropogenic – in natural forests may be undermining this resilience that cannot be fully replaced by tree planting efforts. Climate change and climatic variability and their impacts on natural forest health are reducing the already challenged capacity of forests to secure predictable water flows. Hence, preservation of existing native forests should be a priority in the face of changing climate and associated increased probability of extreme weather events.

4. Forests can be managed for resilience of water supplies to enable adaptation to change if locally relevant data and resources are available. Investments in data collection and interpretation are essential to support evidence-based risk management planning and adaptation.

Hydrological effects of forest disturbance, forest conversion and forestation can be understood through the changes in four ‘ecosystem structure’ descriptors of forests: leaf area index, effective soil cover, soil macroporosity (infiltration rate) and rooting depth. The first can be managed by influencing stand density, the others may primarily be managed (given inherent soil properties) through tree species selection.

Generally, increased forest cover can be expected to have positive effects at local scales (including micro- and meso-climatic effects on temperature and wind speeds), reduced water yields at landscape scales in non-tropical regions, and positive effects downwind in some places at some times. Furthermore, the recovery of aboveground benefits is feasible within a few years, but recovery of belowground benefits (i.e., infiltration and recharge) is often a slower process, counted in decades rather than years. The type of forest cover that is feasible may be constrained by water availability, especially where targets are to be met by planting rather than by natural regeneration. Trade-offs exist between the magnitude and regularity of water flows and associated water quality. These trade-offs depend on the type, density and distribution of tree cover, and require location-specific assessment.

Additional research is needed to better understand the relative magnitude of the effects of climate change and climatic variability, the effects of changes in forest cover, and their interactions on seasonal and annual water yields.

5. Multiple water-related objectives across the portfolio of SDGs present new challenges for policy-makers and managers of forests and landscapes with partial tree cover. New institutional responses are needed to tackle multiple water-related objectives across the portfolio of SDGs, taking a multiple benefits approach.

While a first group of SDGs (especially 1, 2, 6 and 7) implies increased demand for clean, regularly flowing water, a second group of SDGs (especially 5, 10, 12 and 16) implies a change in power-sharing that allows multi-stakeholder involvement, thus increasing the need for transparency and equity in decision-making. The third group of SDGs (13, 14 and 15) establishes targets for resource conservation and restoration that require location-specific scenarios in order to be relevant for local stakeholders rather than relying on generic expectations that all types of forest cover are good for all hydrological functions. Overall, the potential success in avoiding the trespassing of planetary boundaries critically depends on an increase in human adaptive capacity and the ability to transcend existing conflicts; as well as an ability to take a multiple benefits approach and realise positive synergies in addressing SDGs. Information beyond what is currently available is needed to optimise downstream and downwind water availability for the multiple objectives across the portfolio of SDGs.

6. International and regional institutional and governance frameworks can play a key role in optimising climate-forest-water management. New or improved levels of collective action and coordination are needed, including those that coordinate across sectors and across spatial scales.

International governance can play both a symbolic and a substantive role by creating norms (such as the SDGs), by providing fora in which norms can be discussed, negotiated and agreed upon, and by providing opportunities for assessing progress. Strategies that can assist governments and other policy and management entities to move beyond the dominance of entrenched interests and paradigms, including the ability to take a cross-sectoral approach, are important for shifting policy goals away from more profit-oriented toward more sustainability-oriented strategies, policy-building and policy-learning. Furthermore, governance systems with increased polycentrism (characterised by increased reliance on multiple centres of power and multiple levels of decision-making) may provide opportunities for reconciling interests in the decentralisation of decision-making with needs for national and international coordination of policy objectives. Greater reliance on the ideals of participatory and shared governance, as supported, in particular, by the model of polycentrism, may facilitate improved management of top-down and bottom-up forces, as well as to practically realise multi-level adaptive governance.

7. A clear policy gap in climate-forest-water relations exists, waiting to be filled. Forest-water relations deserve at least as much policy attention, from local to global scales, as forest-carbon relations.

The role of forests in current climate policy is defined by targets to reduce net greenhouse gas emissions and increase carbon storage. However, ill-defined local-scale efforts to increase carbon storage may reduce local water availability. It is essential to place water at the centre of discussions of forest-climate interactions in areas of water scarcity because carbon-centred forestation strategies will have important consequences on water resources.

8. Regulations and rights-based approaches to climate-forest-water relations provide an essential foundation for innovation in forest-water governance. Incentive-based mechanisms present opportunities for coordination of interests and concerns in climate-forest-water management but must respect the rights of local, indigenous and other vulnerable communities.

Market-based instruments are increasingly used as strategies to involve non-state actors in taking on the responsibilities of resource governance. Existing and potential future commitments to achieve deforestation-free product and value chains present opportunities for the coordination of up- and downwind, as well as up- and downstream interests and concerns. Such private-public partnerships are well-aligned with the idea of increasing shared governance and polycentrism but must maintain and enhance commitments to the rights of the most vulnerable groups.

9. To successfully achieve SDGs, social and environmental justice, along with equity targets, must be integrated into climate-forest-water policies and management strategies. Already marginalised and vulnerable communities should not be exposed to further risks; opportunities to improve community health and well-being need to be explored when developing forest-water adaptive management strategies.

Changes to the coupled climate-forest-water system will affect the delivery of related ecosystem goods and services and consequent development options. Impacts and consequences of these changes will not be evenly distributed geographically, socially or economically. Any new institutional arrangement should be sensitive to distributional concerns, as well as to social and environmental justice and equity. In particular, the rights of marginalised and vulnerable communities must be protected.

10. The global nature of the current assessment limited the scope to be quantitative and geographically explicit. More quantitative regional-scale case studies that include atmospheric relations, surface and groundwater flows are needed that can be extrapolated to other areas with different social and economic conditions.

A global assessment such as this one could not provide sufficient geographic specification of risks to forest-water relations and management options to reduce these risks. A series of regional/continental assessments, with broad involvement of all relevant scientific disciplines and sources of knowledge is needed to complement and extend the current global GFEP assessment.

Major knowledge and data gaps needed to be filled to inform these regional/continental assessments include the following:

- Specific characteristics of both native and managed forests (e.g., tree species, ages, densities, etc.) that contribute to sustained season and annual water yield, by geographic region.
- Specific locations of forested areas which are most important as sources of water to ecosystems and to downwind and downstream water users.
- Range of variability of forest water quantity and quality as a function of climate change and climatic variability across geographic regions.
- Comparison of changes in water quantity and quality across different land uses.
- Knowledge of how forests and the water that comes from these forests are perceived and valued by local people.