Chapter 1

Forests, Trees and Water on a Changing Planet: A Contemporary Scientific Perspective

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CONTENTS

1.1 Introduction

More than seven billion humans share the planet with approximately three trillion trees (Crowther et al., 2015), 46% less trees than at the start of human civilisation. Approximately 1.36 trillion of these trees exist in tropical and subtropical regions, 0.84 trillion in temperate regions and 0.84 trillion in the boreal region; overall nearly one-third are outside forests (Crowther et al., 2015). There is a wide variation in the ratio of trees to humans and whether or not this matters can be answered in many ways. Even so, we know that the majority of the four billion people facing severe water scarcity (Oki and Kanae, 2006; Rockström et al., 2014; Mekonnen and Hoekstra, 2016) live in areas where forests and trees outside forest are currently scarce.

Perhaps because the co-occurrence of forest and water is so common, water is rarely considered to be a priority in forest management. Forests and trees are important modulators of water flows (Vörösmarty et al., 2000; Bruijnzeel, 2004; Bonell and Bruijnzeel, 2005; Calder et al., 2007), with water flows being among the most prominent determinants of human health and wellbeing (Sullivan, 2002; Falkenmark and Rockström, 2004; Kummu et al., 2010; Rockström et al., 2014). However, as the rate of climate change and the uncertainty of climatic variability continue to increase (Thornton et al., 2014), the relationship between forests and water flow will also change (Caldwell et al., 2012). Would it help to plant more trees? Would this make water scarcity worse? Does it matter what type of trees? Does it matter where and how they are integrated into the landscapes? Are floods and droughts linked?

To respond to these concerns, this Global Forest Expert Panels (GFEP) assessment focuses 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?

The scientific evidence on these questions has not yet been systematically assessed, but partial answers exist for many parts of the world. The world's primary bodies dealing with global climate change (IPCC[1] and UNFCCC[2]) have viewed the role of forests and trees exclusively as carbon sinks and stores. In contrast, water and the role of forests and trees as modulators of the hydrological cycle have not received the explicit attention needed (Díaz et al., 2015; Maier and Feest, 2016; Pascual et al., 2017). The GFEP on Forest and Water recognised that the answers to the three questions would depend on the region of focus and require a timeframe and resources beyond those available at the time. In this GFEP assessment report (hereon the 'report') we identify globally relevant information on forest-water interactions and showcase implications for international policymakers. At the sub-national scale, there is significant variability in the values, priorities and attitudes of local people, associated with changes in the quantity and quality (type) of forests and local drivers of change. The combined effects of climate change, reduced forest functions, and increased demand for water for human health and well-being deserve more explicit attention by our governance systems at, at least, four scales: the local, the landscape, the national and the global (including transboundary) scale.

1.2 Policy Context

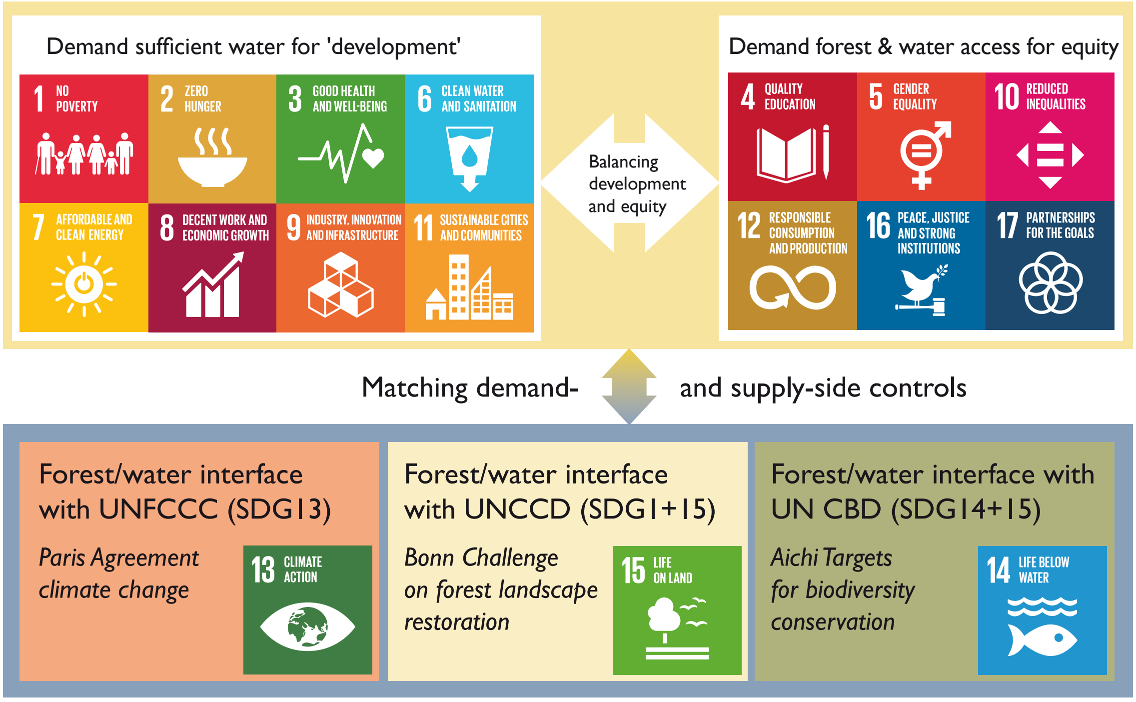
The primary global policy context for this assessment is shaped by the 17 SDGs defined in the Agenda 2030 by the UN in 2015[3]. The SDGs can be split into three groups (Griggs et al., 2013; Figure 1.1):

- **Eight SDGs require an increased supply of safe, secure and reliable water.** SDG 1, 2, 3, 6, 7, 8, 9 and 11 imply an increased demand for water of the right quality and temporal availability, for use in agricultural or industrial production, in support of (hydro)energy, urban systems, sanitation and health services. Goals for the water-energy-food-income nexus and the general requirement of more water for development create challenging contexts which require making trade-offs where water supply is limited, especially when urban and industrial water needs are added to this list of demands.
- **Six SDGs address social justice and equity, and their attainment will reduce unjust and inequitable access to forests and water.** SDG 4, 5, 10, 12, 16 and 17 deal with changes in human and social capital (education, gender, reduced inequality, responsible consumption and production, strong institutions and international cooperation), and their attainment will reduce inequity in access to forests and water, through education, gender equality, conflict management and changes in institutions.
- **Three SDGs build and maintain an ecological infrastructure in support of the other 14 SDGs by adapting to climate change and securing the integrity of the terrestrial and aquatic parts of the planetary system.** The three remaining SDGs deal with climate change (13), integrity of aquatic (14) and terrestrial

[1] Intergovernmental Panel on Climate Change: http://www.ipcc.ch/
[2] United Nations Framework Convention on Climate Change: https://unfccc.int/
[3] https://sustainabledevelopment.un.org/?menu=1300

Sustainable Development Goals (SDGs) in relation to forest/water relations

Figure 1.1



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(15) parts of the planetary system and try to maintain an ecological infrastructure conducive to goals of the first and second group.

The challenge of water security in the face of climate change and increased demands has been recognised at high policy levels (Pittock, 2011; Hussey and Pittock, 2012; Benson et al., 2015; Pahl-Wostl, 2015; Smajgl et al., 2016) but will not be adequately addressed if each of the SDGs (and their associated targets) are seen as independent ambitions (Figure 1.1). Rather, the overall philosophy of the UN SDGs calls for a synergistic approach and integration. Water-relevant targets have been framed for all SDGs (Table 1.1).

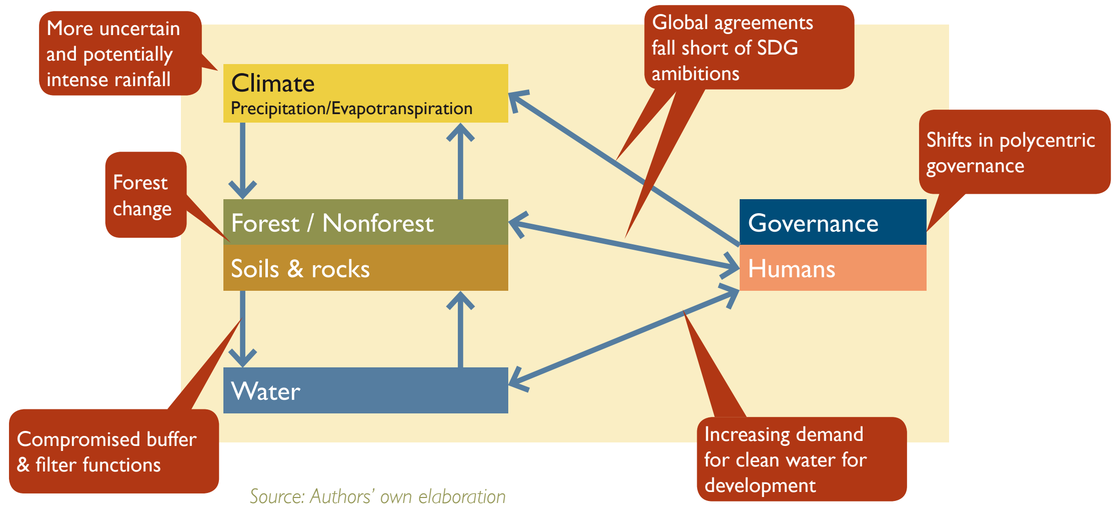
1.3 The Climate-Forest-Water-People System

The four core elements of the system of focus for this assessment are climate, forest, water and people (Figure 1.2).

1) *Climate.* Climate zones are characterised by differences in precipitation and temperature, which are primary determinants of water and energy limitations to evaporation.
2) *Forests.* Biomes vary among these climate zones (Holdridge, 1967). The anthropogenically induced diversity of ***forests and trees*** within each biome can be described as a 'forest transition' (Dewi et al., 2017) – i.e., old-growth (in some rare cases, pristine) forests, secondary forests, agroforests, plantations, agriculture with sparse tree cover and (peri)urban forests. Associated with this forest transition is a range of terms for changes in quantitative and qualitative tree cover, including deforestation, forest degradation, reforestation, afforestation and agroforestation. Defining an operational forest is a non-trivial issue in this context (Chazdon et al., 2016), and here we take an inclusive approach to all tree cover, including trees outside forest (de Foresta et al., 2015), domestic forests (Michon et al., 2007), trees on farms (Zomer et al., 2016) and trees in urban environments (Dwyer et al., 1991; Nowak et al., 2001; Hegetschweiler et al., 2017).
3) *Water.* Various parts of the global hydrological cycle have been studied as '*blue water*' (in streams, rivers, lakes or groundwater stocks and available for a range of human uses) and '*green water*' (held in the soil and vegetation and available for use by plants and/or slow release to 'blue water' forms) (Falkenmark and Rockström, 2006). A further colour of water closes the hydrological cycle: '*rainbow water*' which is atmospheric moisture, as a potential source of rainfall (van Noordwijk et al., 2014), also known as 'invisible' water (Keys et al., 2016) or 'rivers in the sky' (Arraut et al., 2012; Witze, 2015). In colder climates some precipitation is in the form of snowfall and seasonal temperature matters for its phase change to blue or green water. In cloud forests, rainbow water can be captured by vegetation as 'horizontal' precipitation; and, in response to temperature fluctuations, condensation of dew on plant surfaces can similarly make water available without measurable rainfall.

Core relations between subsystems as focus for this report and the global changes that are affecting the way forests function in relation to water supply

Figure 1.2



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Sample of the specific targets within the SDG framework that are relevant to this GFEP report (UNGA, 2015)

Table 1.1

Target 4.7	By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and nonviolence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.
Target 6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.
Target 8.4	Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead.
Target 10.2	By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.
Target 12.8	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.
Target 13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
Target 13.2	Integrate climate change measures into national policies, strategies and planning.
Target 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, in line with obligations under international agreements.
Target 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.
Target 15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.
Target 15.9	By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.
Target 16.6	Develop effective, accountable and transparent institutions at all levels.
Target 16.7	Ensure responsive, inclusive, participatory and representative decision making at all levels.
Target 17.14	Enhance policy coherence for sustainable development.
Target 17.15	Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development.

Existing meteorological precipitation data, therefore, only represent part of these inputs of water to vegetation. There is an increase in uncertainty and related challenges for policy and management decisions from *'blue'* to *'green'* to *'rainbow'* water.

4) *People.* People depend on water for a multitude of functions – e.g., drinking water, sanitation, irrigation, transportation, hydropower generation and industrial cooling and processes. Dependency on surface-, ground- or piped water from non-local sources determines substantial variation in water security and vulnerability to climatic variability among social strata. Vulnerability is also associated with gendered differentiation of roles and rights in relation to access to water. Governance in this context, represents the set of formal and informal institutions and behaviours (actors, actions and rules) through which people act to alter forests and water. Many forms of governance are possible, at many scales.

In our GFEP report, the climate-forest-water-people system and all of the interactions this entails are considered. Specifically, climate is a cross-cuttting theme and 'Water for forests', 'Forests for water', 'Water/forests for people' and 'People for forests/water' are considered.

1.4 Risks to the Climate-Forest-Water-People System

Climate change is not just an issue of increasing temperature, but a symptom of more encompassing changes to the global energy balance and water cycle. Human populations and societies have risen and fallen, large areas of forest have been cut down and regrown, and the climate has varied before (Williams, 2003). The current 'Anthropocene' era, however, is the first geological period globally dominated by a single species (Crutzen, 2006; Waters et al., 2016). Climate, water availability, forest conditions, water management and societal expectations are changing very rapidly (Milly et al., 2008). We are in a 'new normal' of ongoing change (Rosegrant et al., 2012; Angeler and Allen, 2016). Today's decisions must anticipate changes that will occur during the lifetime of trees that start to grow now.

The concept of "Planetary Boundaries: Exploring the Safe Operating Space for Humanity" (Rockström et al., 2009a, b) puts a spotlight on the unsustainability of current development trajectories and ambitions with the idea of a 'safe space'. The basic premise is that this safe space is bounded in at least nine dimensions by limits to human resource appropriation and disturbance of nutrient and water cycles. Transgression of any of the nine boundaries will be "deleterious or even catastrophic due to the risk of crossing thresholds that will trigger non-linear, abrupt environmental change within continental- to planetary-scale systems" (Rockström et al., 2009a). Positive feedback and accelerated change may lead to abrupt shifts to alternate configurations, radically different from the current situation, for example in atmospheric or ocean circulation or terrestrial climates. Rockström et al. (2009a) suggested that three of these nine boundaries have already been exceeded, and that for all others the current trajectory is heading for the boundary, rather than away from it. Despite debate (e.g., Montoya et al., 2018), the concept of planetary boundaries to human resource appropriation is a key feature of contemporary discourse on environmental policy.

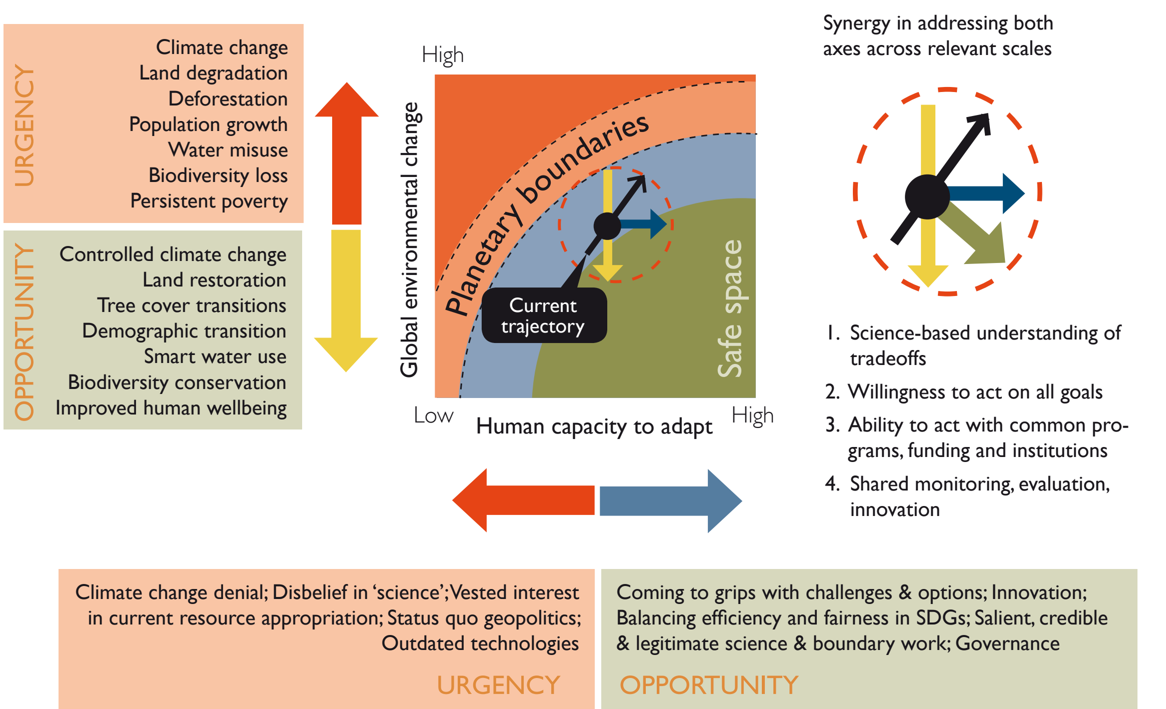
An extension of the concept of planetary boundaries is to shift the focus from just the Earth system to the role of humans in this system (Figure 1.3). Both human appropriation of global resources and human capacity to adapt define the safe space. If human capacity to adapt is low (for example by remaining in denial phase for issues such as global climate change or by systematically discrediting results obtained through scientific analysis) maintenance of the current resource appropriation trajectory makes collapse more likely.

We adapt the extended concept of planetary boundaries to deal with renewable resources such as forests and water. Seen from this perspective, two equally important shifts are (on the ecological Y axis) a rapid halt to, and reversal from, the current tendency towards increased human appropriation of global resources (including forest and water) and (on the social X-axis) an increased human capacity to adapt. Under this perspective, issues of forest and water cannot be singled out for separate action. Steps in the desired direction may need a combination of: 1) science-based understanding of tradeoffs, 2) willingness to act on all goals, to maximise the platform for positive change, 3) the ability to act with common programmes, funding and institutions, and 4) shared monitoring, evaluation and innovation, to ensure effective learning loops.

A systems approach supports the consideration of interacting scales (global to local, and back) (Rockström et al., 2014), captures interdisciplinary aspects (MEA, 2005; Díaz et al., 2015; Pascual et al., 2017; Ellison et al., 2017) and considers multiple interacting knowledge systems between policy arenas, local stakeholders and various types of science (Leimona et al., 2015; Clark et al., 2016; Creed et al., 2016; van Noordwijk, 2017). The risk management standard (ISO 31000) of the International Organization for Standardization (ISO) is a globally-accepted system that provides an opportunity to manage risk in a structured manner within the scope of a given policy objective. Within the ISO 31000 standard, the ISO 31010 Bowtie Risk Management Assessment Tool (IEC/ISO, 2009) has been used to evaluate the overall performance of a system of management measures that was put in place to reduce risk and achieve policy objectives. Governments around the world are starting to use the ISO 31000 and ISO 31010 tools to improve ecosystem management (e.g., Creed et al., 2016; Kishchuk et al., 2018) and to assess governments' ability to achieve the SDGs. We apply this framework to identify, analyse, evaluate and treat the risk of not meeting the SDGs by mismanagement of the forest-water relationship.

Figure 1.3

Two main axes that determine current trajectory for humankind interacting with planetary boundaries: global ecological change on the Y-axis, and human capacity to adapt on the X-axis. The current trajectory is towards increased human appropriation of global resources (including forest and water)



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1.5 Structure of the Report: Considering Risk in a Systematic Way

The structure of this GFEP report is inspired by the Bowtie Risk Management Assessment tool (Figure 1.4). We linked drivers of forest and land use change to pressures on ecosystem structure and changes in ecosystem functions. These pressures affect ecosystem services and their delivery to people, leading to a range of prevention controls to reduce pressures caused by drivers or mitigation controls to reduce impacts or to enable adaptation, at local, landscape, national and international scales.

Furthermore, this GFEP report zooms in from global-to-local scales to diagnose current risks, and then zooms out in considering options to adapt to global change, or deal with its consequences. Specifically, the structure of the report is as follows:

Chapter 2 reviews the science underpinning seven of the 10 system delineations (Figure 1.5) that represent 'building blocks' for the current report; it clarifies the interactions between climate, forests and water regimes at the landscape scale, focussing on the current situation (*status quo*) as a basis for the system response to ongoing change. It also introduces the social and governance dimensions of dynamic social-ecological systems;

Chapter 3 describes the determinants of change in the forest-water relationship, and global drivers of change that affect climate, forest, water and people at the landscape scale. This chapter highlights the relevance of time and space when considering the role of drivers on the social-ecological system;

Chapter 4 synthesises understanding of the hydrological effects of the changes described in Chapter 3; hydrological regimes in forests and land with partial tree cover are shaped by interactions and feedbacks between climate and vegetation with implications for local and global hydrology;

Chapter 5 presents future scenarios of forest-water ecosystem services that relate the rate of global change to the capacity of people and their governance systems to adapt;

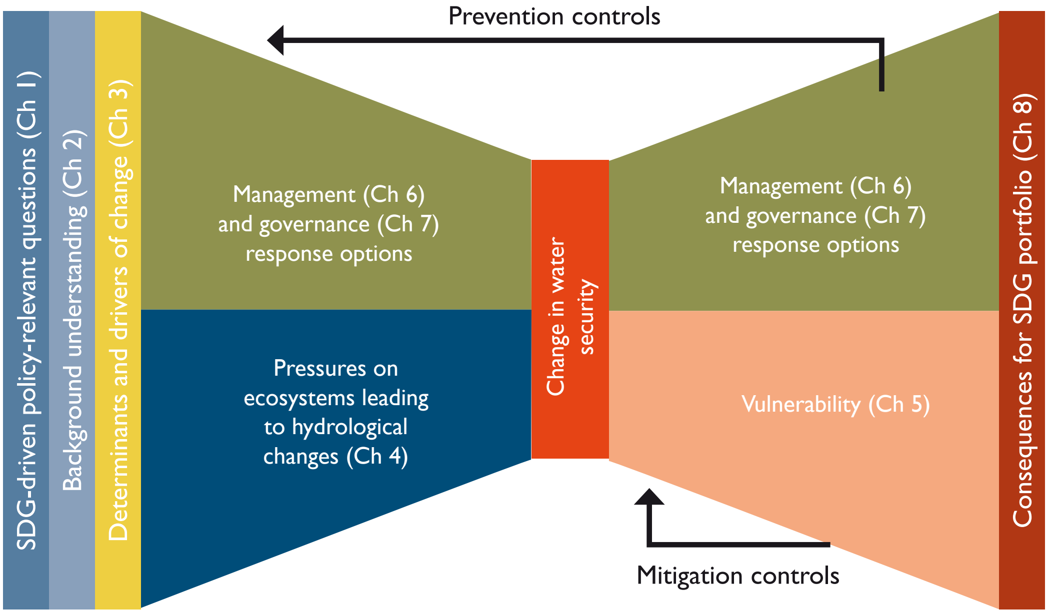
Chapter 6 presents management options to address stresses on the forest-water-climate system at the catchment scale;

Chapter 7 considers options for policy and governance responses at the landscape, national and international scales; and

Chapter 8 provides the main conclusions, summarises outstanding research gaps and highlights points of relevance for policy dialogue;

The ISO 31010 Bowtie Risk Management Tool inspired the structure of this GFEP report

Figure 1.4



Source: Authors' own elaboration

Box 1.1

Shoulders on which we stand…

A selection of titles indicates the range of textbooks, reviews and expert syntheses that form a backdrop to current thinking. Their authors are the shoulders on which we stand, allowing us (as Newton) to see further.

These include (in chronological order):

Principles of forest hydrology (Hewlett, 1982)

Forests, climate, and hydrology: regional impacts (Reynolds and Thompson, 1988)

Climate, water and agriculture in the tropics (Jackson, 1989)

Elements of physical hydrology (Hornberger et al., 1998)

The blue revolution: land use and integrated water resources management (Calder, 1999)

Forests and water, international expert meeting on forests and water, 20-22 Nov., 2002 Shiga, Japan (International Forestry Cooperation Office of Japan, 2002)

The cost of free water: The global problem of water misallocation and the case of South Africa (Bate and Tren, 2002)

World water and food to 2025: dealing with scarcity (Rosegrant et al., 2002)

Deforesting the earth: from prehistory to global crisis (Williams, 2003)

Forests, water and people in the humid tropics: past, present and future hydrological research for integrated land and water management (Bonell and Bruijnzeel, 2005)

Forests and Floods: Drowning in Fiction or Thriving on Facts? (FAO-CIFOR, 2005)

Forest hydrology: an introduction to water and forests (Chang, 2006)

Towards a new understanding of forests and water (Calder et al., 2007)

Hydrologic effects of a changing forest landscape (National Research Council, 2008)

Floods, famines, and emperors: El Niño and the fate of civilizations (Fagan, 2009)

Sustainability science for watershed landscapes (Roumasset et al., 2010)

Hydrology and the Management of Watersheds (Brooks et al., 2013)

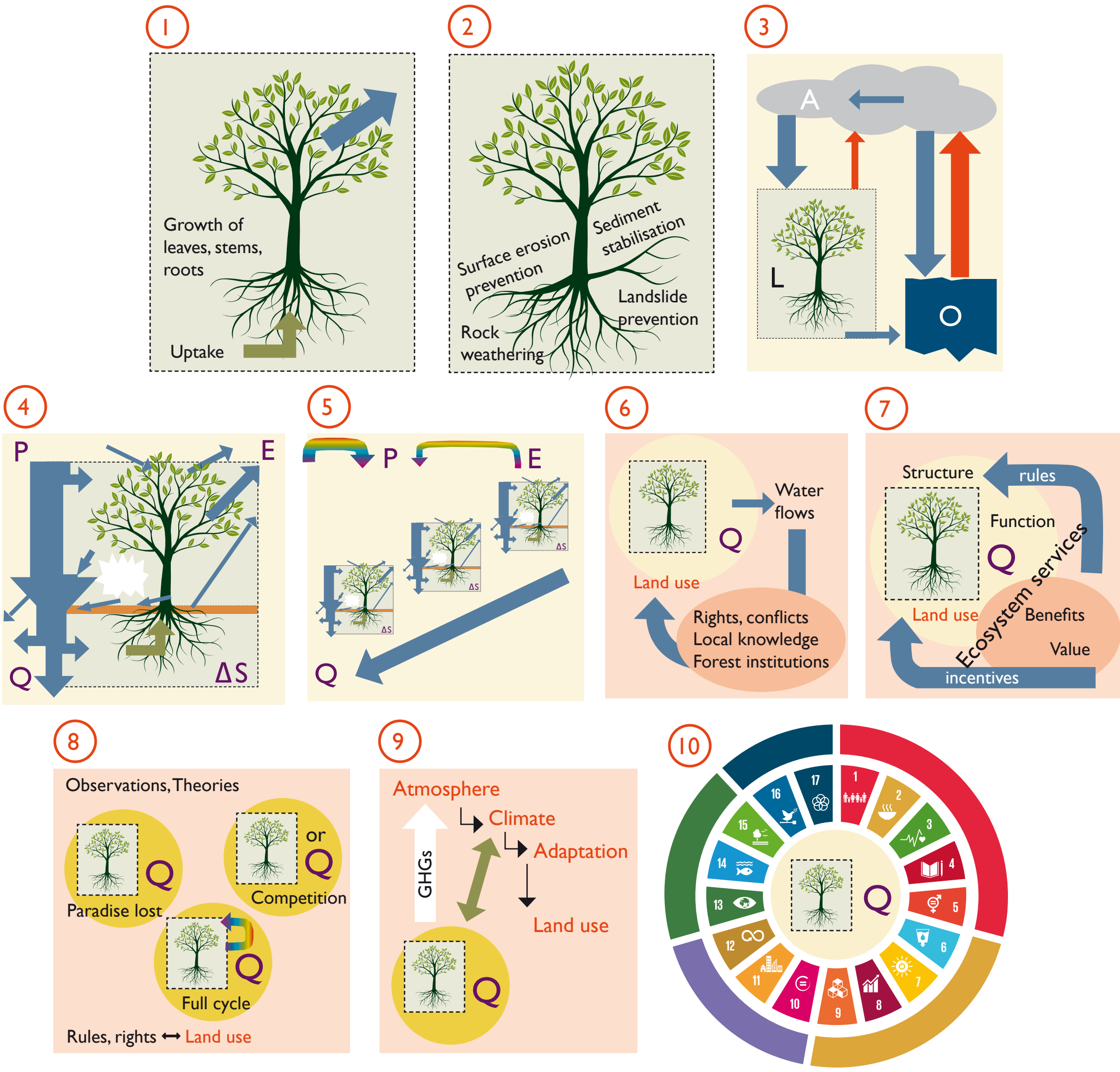
1.6 Strong Foundations and Emerging Perspectives

This report is by no means the first time the relationships between forest and water are reviewed (Box 1.1). While acknowledging solid foundations and excellent previous reviews, we found that our questions on the way forest-water relations interact with the SDG portfolio as a whole have hardly been asked, let alone answered. Yet, our literature review showed significant progress in the past decade for many 'subsystems' (Figure 1.5), that have a much narrower delineation.

Probably the largest progress in the past decade is the acknowledgement of the feedback loops between the four elements of the system and the full hydrological cycle. The hydrological system has been described as a cycle for hundreds of years. Yet, most of hydrology as a science has been based on a flow perspective, where incoming precipitation is the starting point and its subsequent use is the primary concern for practitioners as well as science.

Ten subsystems of the climate-forest-water-people system studied in the scientific literature

Figure 1.5



1. Trees and water (structure and function of leaves, stems and roots), *part of*
2. Forests, soils and climate (sponge effects), *part of*
3. Atmosphere, oceans and terrestrial vegetation (global water fluxes), *part of*
4. Precipitation, evapotranspiration and discharge (water balance and buffering), *part of*
5. Dynamic landscape mosaics (streamflow), *part of*
6. Land and water use rights, local knowledge and forest institutions (landscapes), *part of*
7. Social-hydrological systems (ecosystem services as valued human benefits).

In addition, there are systems that build on the first seven nested systems that explore governance of society, including:

8. Contested and evolving forest-water paradigms in public discourse, legislation and underpinning existing policies;
9. Climate change policy in its relation to forest and water interaction; *and*
10. SDG coherence in an interlinked, multiscale and polycentric governance perspective.

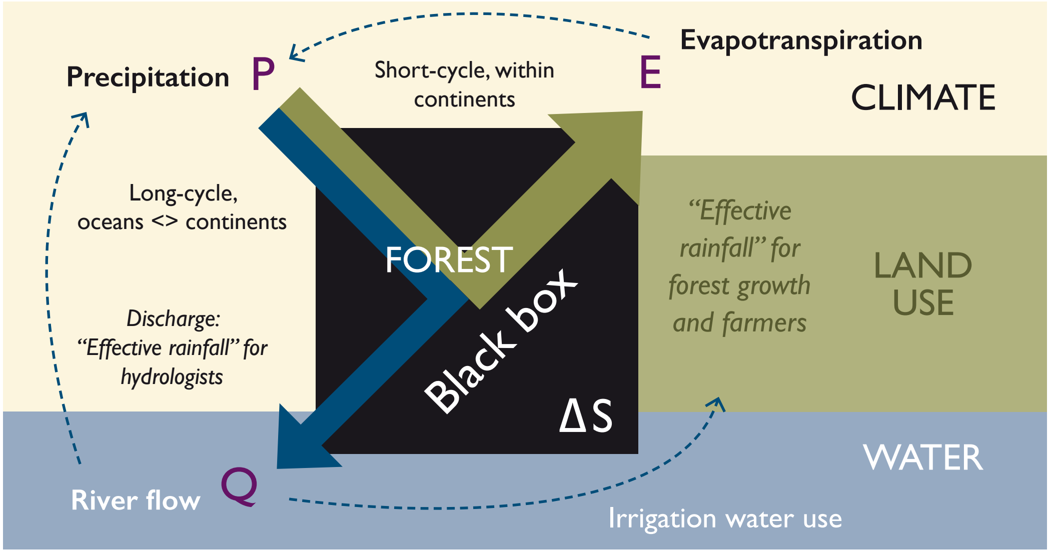
Source: Authors' own elaboration

It has taken some time before managers of a national economy realised that they were not just dealing with stocks and flows, but with a cycle, where cause-effect relations represent feedback loops. Similarly, understanding of the full hydrological perspective has been slow to emerge across scales and spheres of influence (Figure 1.6). Cyclical relations in a climate interacting with oceans and vegetated land masses are only partially addressed in current greenhouse gas and carbon dominated climate discourse (see Chapter 2).

This important change in our understanding has implications for forest-related policies which should consider not only carbon-related forest ecosystem services but also water-related ones. Major policy instruments such as REDD+ (reducing emissions from deforestation and forest degradation plus sustainable forest

Hydrological cycle and the way precipitation (P) is partitioned over evapotranspiration (E) and river flow (Q) at time scales in which the change in soil water storage (ΔS) is considered to be negligible

Figure 1.6



Source: Authors' own elaboration

management and restoration) have failed to deliver on the expectations raised (Minang and van Noordwijk, 2013; Matthews et al., 2014; Matthews and van Noordwijk, 2014), especially from a local perspective (Bayrak and Marafa, 2016; Sanders et al., 2017), where issues of water are more relevant than the rather abstract concept of carbon accounting. While some authors remain optimistic on REDD+ (Brockhaus et al., 2017), there certainly are important lessons on institutional development (Minang et al., 2014) that can be used in a new round of policies that look at the climate-forest-water-people interactions in a more holistic way, as this GFEP assessment report shows. Water may be the key to unlocking policies that flow readily from local to global scales.

1.7 No Simple Rules to Guide Policy: Perspectives Addressed in this Assessment

The questions that this report sets out to address are only partially addressed by current forest hydrology as a relatively well-defined discipline (Hewlett, 1982; Chang, 2006; Brooks et al., 2013). To operate effectively at the science-policy interface, an assessment such as this must relate to multiple knowledge systems (Jeanes et al., 2006; Rahayu et al., 2013; Leimona et al., 2015; van Noordwijk, 2017) compared to those that have historically shaped laws and institutions plus those influencing today's decisions. Simplifying a richer and more complex reality, we identify three perspectives concerning the forest-water relationship: 'no forest-no water', 'more forest-less water', and 'it depends' (Figure 1.7), with a swinging back and forth among these three perspectives.

Perspective 1: No Forest – No Water/More Forest – More Water

The first perspective is that all aspects of forests are positive for any issue related to water, and that any problem of flooding, droughts, landslides or pollution is the direct consequence of deforestation or forest degradation, with restoration and reforestation as logical, universal solutions; in slogan format: *No Forest, No Water*.

Perspective 2: More Forest – Less Water

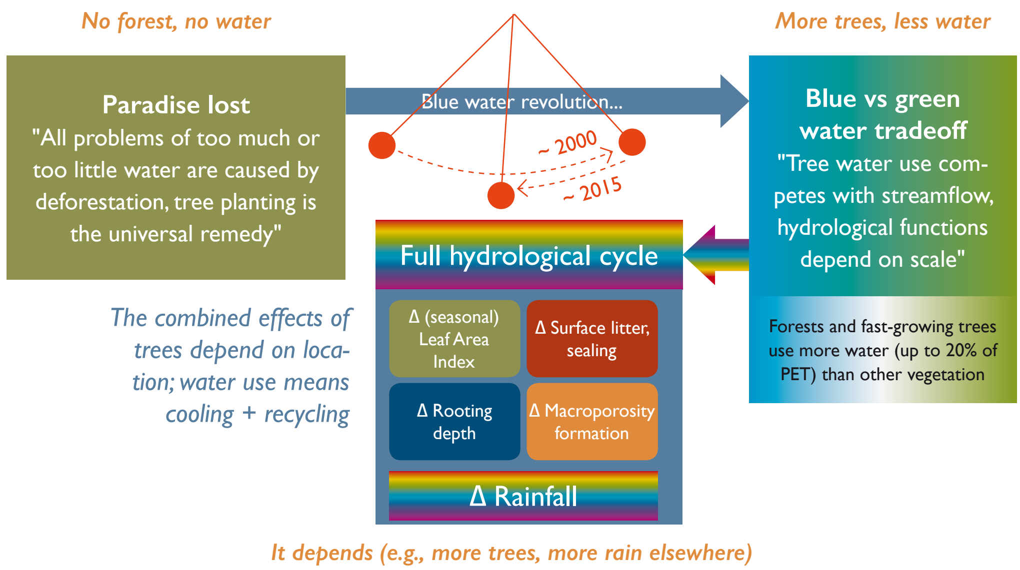
The second perspective is that trees use more water than other vegetation, that the evidence for linking deforestation to floods in anything but a small catchment is weak, and that there is a near-universal loss of 'blue water' when there are more trees using 'green water'. Climate change is the primary culprit of floods. Large-scale reforestation does not increase (but rather decreases) total water yield, but also (in many cases, at least) dry-season streamflow; in slogan format: *More Trees, Less Water.*

Perspective 3: It Depends

A 'full hydrological cycle' perspective of forests and water demands a more nuanced, spatially explicit position that, depending on the context, changes in tree cover can be related to a range of quantifiable functions and their trade-offs. This 'it depends' rule suggests that a "right tree at the right place for a clear function" concept should replace blanket reforestation targets. Furthermore, it combines the two apparently conflicting perspectives above, and focuses on identifying particular types of benefits for particular groups.

Cartoon of a pendulum swinging between three public perspectives of the key forest-water relations

Figure 1.7



Source: Authors' own elaboration

It is from the 'it depends' perspective that the GFEP assessment report builds a scientific foundation (in Chapters 3, 4 and 5) for policy and management (Chapters 6 and 7).

1.8 Scope and Objectives of the Global Forest Expert Panel on Forests and Water

The Collaborative Partnership on Forests (CPF)[4] established a GFEP on Forests and Water through its Global Forest Expert Panels initiative. Like previous Global Forest Expert Panels, the aim of this Panel is to provide policy-relevant scientific information to intergovernmental processes and institutions related to forests and trees, thereby supporting more informed decision making by policymakers, investors, donors and other stakeholders, and contributing to the achievement of international forest-related commitments and internationally-agreed development goals.

The GFEP on Forests and Water[5] was tasked to "carry out a comprehensive global assessment of available scientific information about the interactions between forests and water, and to prepare a report to inform relevant international policy processes and the discussions on the 2030 Agenda for Sustainable Development and related Sustainable Development Goals". The scientists on the panel defined a more detailed outline and reviewed recent literature on the specific questions that emerged. The report has been peer reviewed anonymously.

The ***scope*** of the review has focused on issues of flow regime as influenced by changes in forests and tree cover, specifically water quantity and flow regularity, with a focus on surface water and atmospheric moisture flows. Other parts of the forest-water nexus are discussed but without the depth that we had hoped for, as many of the issues were site or location specific and generalisations were weak (e.g., as for water quality issues). Groundwater dynamics, the relation between tree cover and dryland salinity, and consequences for land subsidence of groundwater extractions (as they plague a metropole like Jakarta, for example) were deemed beyond the scope of this report.

The ***objectives*** for this review are to provide an independent expert evaluation of the science-based evidence and/or major gaps of:

1) The functions that forests provide in influencing the relationship between climate and the timely availability of good-quality water to match human needs;
2) The risks that these functions are compromised by changes to forest conditions; and
3) The need for further policies and management strategies to reduce risks and deal with its consequences.

[4] More info about CPF and its members: http://www.cpfweb.org/73947/en/
[5] More info on the GFEP on Forests and Water: https://www.iufro.org/science/gfep/forests-and-water-panel/

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