Forests, soil, water, and their linkages through the biosphere

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Humans and trees have to share the planet’s water resources

- 7 billion people on the planet
- 1,736 billion trees on the planet
- Very few trees on arid regions
- 4 billion people suffer from water scarcity
The relationships between forests and water have long been recognized as important, and the debate keeps going on.

Would planting trees help to increase water availability?

Are floods, droughts and trees connected?

Would planting trees reduce water availability?

Does it matter what type or trees, or where they are planted?
The latest Global Forest Expert Panel on Forests and Water try to answer three questions:

1. Do forests matter?
2. Who is responsible and what should be done?
3. How can progress be made and measured?
The ISO-31010 Bowtie Risk Management Tool inspired the structure of the report
Ten nested systems of increasing complexity and scale

Source: Authors’ own elaboration

P = precipitation
E = evapotranspiration
Q = river discharge
ΔS = change in storage
ES = ecosystem services
Forest influence the local hydrological cycle

Forest influence the global hydrological cycle

Forests influence water provision for human activities

Forest management can influence the local/regional hydrological cycle

Take-home messages
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.
Trees are biological entities that need water to survive: they take water from the roots, lose it from the leaves.
The forest + soil system = a sponge that stores water
Forests are terrestrial ecosystems that are linked to ocean systems through precipitationsheds.
The “Short cycle” (water recycled over land systems) means that water is used 2.7 times before returning to sea.
River discharge = Precipitation – Evapotranspiration – Storage increase (soil, plants, underground)
Type of forests, placement of forests, seasonal patterns, and topo-geological factors combined produce discharge.
Forests pump moisture into the atmosphere that is displaced further inland: precipitation recycling

Average continental precipitation recycling ratio $\rho_c$ (1999–2008).

(Van der Ent et al., 2010)
Landscape mosaics and tree cover transitions are caused by complex socio-ecologic interactions.
Forests provide an important battery of water-related ecosystem services
Forests provide an important battery of water-related ecosystem services

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Source: van Noordwijk et al., 2016; Lusiana et al., 2017
Different management strategies will have impacts at different scales

1. **At watershed scale**, managing for tree growth or biodiversity (carbon sequestration, forest biomass) likely would reduce water yields due to evapotranspiration. However, some degree of tree cover would increase water recharge even in arid regions.

2. **At regional/continental scale** forest management could be used to redistribute atmospheric water across continental areas. For example, restoring forest landscapes across a flood-prone region could reduce water flows in that watershed but transfer more precipitation to other watersheds more inland.

3. **Critical Water Zones** must be identified and specifically managed to ensure water flow and quality (i.e. “water towers”).
Relationship between forest management and water-related issues depends on the local and regional context.

Flooding in the Huong River Basin, Central Viet Nam.

Source: Redrawn from Tran et al., 2010.
Still, important unknowns must be clarified

1. **What are the characteristics of** natural and managed forests (e.g., species, ages, densities) that contribute to sustainability of water supply?

2. **What are the locations** of forested areas that are most important as sources of water to ecosystems and to downstream and downwind users?

3. **What is the uncertainty** in forest-water relations as a result of the cumulative effects of climate and land use/land cover changes across geographic regions?

4. **How** are forests and the water that comes from forests are perceived and valued by people?
Take-home message: we need to manage forests for water

1 Rethink forests as sources of water:
   Forests contribute to water supplies, both downstream and downwind, at a range of spatial and temporal scales.

2 Reposition forest-water discussions:
   Forest-water relations must be central to policy discussions at regional, continental and international scales.

3 Reimagine interventions:
   New institutional and governance frameworks that permit holistic consideration of forests and water are needed to create local policies that support global water security.

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