MANAGING FORESTS FOR WATER AND FOR CLIMATE COOLING

It is well known that forests purify water and overall are essential for water availability and global cooling at multiple scales: at watershed, regional and continental levels. New research[1] reveals that the following five forest processes are more important than previously thought, and that management to support them can result in short and long-term benefits for water availability and climate:

1. Forests promote precipitation.
2. Trees and forests are natural cooling systems.
3. Forests generate air and moisture flows.
4. Trees and forests can improve groundwater recharge.
5. Forests can moderate flooding.

With increasing water scarcity, climate change, and growing demands on forest resources, it is vital that we gain greater understanding of fundamental forest-water-climate relationships. A lack of clarity on these issues is a major constraint to implementing policy and practice that can optimize ecosystem services, and thus, the socioeconomic benefits of forests.

Objectives

- To provide policy makers with concise and clear information on the central role of forest and tree cover in supporting Earth system processes that are crucial to the water cycle, and maintaining the quality of human life.
- To raise awareness of new findings on the importance of forests, as outlined in strategies addressing climate change mitigation and adaptation, water management, and land-use planning.
- To encourage multiple sectors to engage in sustainable forest management as part of broader landscape management.

[1] In June 2015, over 30 experts in the fields of Earth and plant sciences convened in Leuven, Belgium, to discuss the latest scientific findings related to forest, water, soil and atmosphere interactions. They consolidated research showing how forests regulate water and climate, not only at local, watershed and catchment scales, but also at regional, continental and global scales. This policy brief reflects these findings.

1

Forests promote precipitation

- Terrestrial evapotranspiration contributes to approximately 40% of rainfall over land.
- In the tropics, air that has passed over forests produces about twice as much rain as air that has passed over sparse vegetation.
- Deforestation causes a decrease in rainfall by reducing evapotranspiration, thereby restricting the availability of atmospheric water for rainfall up to thousands of kilometers downwind.
- Trees emit biological particles found on the surface of leaves into the atmosphere, some of which actively produce rain and snow in a process called *bioprecipitation*. These biological particles are more efficient at generating precipitation than other atmospheric particles.

Action: Promote integrated sustainable landscape management, taking into consideration species composition (from microflora to trees), and the spatial distribution of forests at national, regional and continental scales.

2

Trees and forests are natural cooling systems

- Temperatures under tree and forest cover, in both tropical and temperate regions, are significantly cooler than in croplands, open areas, or urban spaces.
- Trees use solar energy for transpiration. Solar energy is also used in the evaporation of water from forest canopies and soils. Similar to perspiration on human skin, these processes reduce the temperature of the Earth's surface. For example, forested areas in the countryside can be up to 20°C cooler than open areas or croplands.
- In a single day, one tree has the equivalent cooling power of two households using air conditioning. Using trees to reduce temperatures can result in calculable economic returns, by reducing the need for air conditioning and its associated costs.

Action: Promote tree and forest cover in areas that are susceptible to high temperatures, such as urban areas.

3

Forests generate air and moisture flows

- Trees and forests are sources of atmospheric airflow patterns.
- Large forested areas with continuous tree cover from coastal to inland areas can carry atmospheric moisture deep into the interior of continents.
- Coastal forests draw in moist air from the ocean as part of the evapotranspiration process, initiating a cycle whereby moist air is carried further inland to drier areas.

Action: Endorse reforestation, afforestation, and the conservation and expansion of forests along existing airflow patterns, in order to promote the transcontinental transport of atmospheric moisture.

4

Trees and forests improve groundwater recharge

- Trees and forests improve the infiltration of water into soils. Without tree cover, soils become degraded (i.e. lower organic carbon and nutrient content, poor structure, lower water holding capacity), thus reducing their capacity to absorb water and promoting surface runoff and erosion.
- Trees create macropores through their roots and associated soil fauna. Water can move preferentially and very rapidly through these macropores, bypassing much of the soil matrix.
- The shade and litter under trees also help to absorb water, reduce soil evaporation, and promote soil fauna.
- Reforestation in degraded lands can improve groundwater recharge if the gains from improved infiltration, preferential flow and decreased evaporation exceed transpiration losses.

Action: Encourage reforestation and afforestation of degraded lands using appropriate tree densities, to foster groundwater recharge by improving infiltration, preferential flow and reducing losses through soil evaporation.

5

Forests regulate river flows

- River flow varies with rainfall. Forests buffer fluctuations in flow through soil infiltration and groundwater recharge. Groundwater recharge contributes to base flow, the availability of water during dry seasons, and may also feed springs lower on the slopes.
- The loss of forest cover often leads to reductions in water infiltration, thus increasing overland flows. This can lead to increased erosion and the sedimentation of water courses. While deforestation may reduce the amount of water used by trees and increase the amount of water in rivers, the availability of this water is less reliable. This is because trees and forests play an important role in transpiration, evaporation and the infiltration of water into soil surfaces and groundwater recharges.
- The reduced predictability of river flows increases the risks of floods and droughts.

Action: Land management approaches should consider trade-offs between increased flows versus decreased storm runoff and sedimentation, improved water quality, and base flow conservation.

Recommendations

- **Integrated sustainable landscape management**
  Approaches to forest management should extend beyond the catchment or watershed scale, and should consider forests within a broader landscape that includes a mosaic of land uses. This integrated landscape approach should consider species composition (from tree species to micro-flora and fauna), as well as the spatial distribution of forests at national, regional and continental scales.
- **Appropriate reforestation and afforestation**
  Strategic reforestation and/or afforestation can have multiple benefits, including reducing local temperatures, increasing water availability, reversing soil degradation, and mitigating floods. Appropriate sites, species composition, and management regimes should be selected to balance trade-offs, minimize negative impacts, and maximize positive synergies.
- **Restoration and conservation of existing forests**
  The prevention of further deforestation and forest degradation is the most effective and efficient way of ensuring that the ecosystem services provided by forests (e.g. water provision and regulation) are maintained. The restoration of forests can reverse soil degradation; improve groundwater recharge by facilitating infiltration; and reduce water losses to surface evaporation, runoff, and erosion.
- **Management for trade-offs**
  The management of forests and landscapes should be based on a sound understanding of the benefits and costs associated with management decisions at multiple geographical scales, in both the short and long term.
- **Policy and practice based on scientific knowledge and understanding**
  Forest, water, and climate policy and practice should be based on improved scientific understanding. Stronger linkages and communication between scientists (ecologists as well as foresters), policymakers, and practitioners is needed, to ensure that forests and landscapes are sustainably managed. Furthermore, greater investment in scientific research is required to further improve our understanding of forest-water-climate interactions, and the implications of policy and management on these interactions.

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Forests promote precipitation

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WeForest is an international NGO dedicated to the reforestation of degraded landscapes. It promotes scientific evidence for the ways in which forests contribute to climate change mitigation, beyond their impacts as stocks of carbon, by increasing water availability and enhancing local cooling.

WeForest
Making Earth Cooler