AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly Magazine
Volume 5, Issue 12
www.agriallis.com

Article Id
AL04291

FOREST AND WATER NEXUS – INTRODUCTION

Dinesh Choudhary

Email

dineshbabriyajaat@gmail.com

Department of Soil Science and Agricultural Chemistry, CPGS-AS
(Central Agricultural University, Imphal), Meghalaya- 793103, India

Identify forest-water interactions in general, and with respect to different landscape scales; recognize pathways through which forests can influence water quantity, quality and timing; and explain how forest-water interactions result in environmental, economic and sociocultural benefits for people and the planet. First, I want to remind you why water and trees - within and outside forests - are among the most important natural resources for people on planet Earth. Together, they: host a large part of Earth's biodiversity provide food and energy. Trees and water are highly interdependent resources that influence each other at various spatial and temporal scales, from one tree all the way to entire continents.

Tree-water Interactions

Trees and water interact in many ways:

Evapotranspiration:- The combined process of: loss of water through **evaporation** from the soil surface and rainwater trapped on leaves; **transpiration** through the leaf surface of water transferred from the roots to the leaves. These two processes occur simultaneously and the evapotranspired moisture enables precipitation.

Infiltration and groundwater recharge:- Tree roots and enhanced levels of soil organic matter from litter inputs improve soil structure and water infiltrating capacity.

Precipitation formation:- Release of biological particles from trees (spores, pollen, etc.) attracts atmospheric moisture and facilitates cloud formation and rainfall.

Fog/cloud trapping:- Trees in high altitudes have the ability to collect additional moisture from clouds and fog, adding to infiltration and groundwater recharge.

Flood moderation:- Trees and X their impact on soil reduce speed and quantity in stream flows and reduce erosion in local catchments (i.e. water capture areas).

Even though we often speak of the water cycle, there in fact two different water cycles, which are interdependent and vary according to temporal and spatial scales. The short (closed) water cycle refers to local circulation, above continents or oceans. The long (open) water cycle refers to the circulation between continents and oceans. By storing and transporting large amounts of water, forest ecosystems play an integral role in regulating the timing of water flows of both cycles.

Influence on Water Quality, Quantity and Timing

I understand the tree- water interactions and the role of forests in the water cycle, but I don't see how they directly influence water. The water cycle is complex, and there is a lot to unpack in order to understand its mechanisms. Let's focus on the influence of trees and forests on water quality, quantity and timing.

Water quality:- Forests play a key role in purifying water. They provide natural filtration of sediment, nutrients and pollution compounds transported in the water. Forest management practices can affect drinking water quality, locally and downstream. The regulation of water quality is one of the most important ecosystem functions of forests. It is estimated that nearly 800 million people - about 10% of the world's population - lack basic drinking water services. At least 2 billion people around 2 out of 10 people use unsafe drinking water sources that can cause diarrhoea, cholera, dysentery, typhoid and polio.

Water quantity and timing:- Now regarding water quantity, the water flow is not consistent throughout the landscape. The key factors affecting water quantity and flows in the landscape are: **Climate:-** Total rainfall amount and rainfall intensity, **Topography:-** Slope gradient and length, **Land cover**:-Vegetation type and density and **Soils:-** Texture and structure.

These factors influence the formation of water courses, as well as groundwater and soil saturation. Forest cover will intercept and slow runoff, increase infiltration and evapotranspiration while cleared, hard or built-up areas have fewer capabilities to perform these functions, and are more likely to be flooded and contribute to erosion. The relationship between forests and water quantity and timing is highly contextual, with many trade-offs to account for. We will explore those in more detail later.

Scale Matters and Optimal Density

Scale matters are mainly two types:-

1. **Temporal scale:-**To better understand whether forests are water users or recyclers, we should look at the temporal and spatial scales. Starting with the temporal scale, the tree life cycle is closely related to trends in the water cycle. Trees have different water requirements, depending on the life cycle stage they are at. However, the impacts of trees on water availability will also depend on factors such as the type of forest, tree density, tree species, and tree water-use efficiency. Forest restoration may positively impact water yields, depending on when the restoration started.

2. Spatial scales:- There is a variety of definitions of spatial scales. In this course, we will use the scales outlined in this publication from the International Union of Forest Research Organizations (IUFRO). **(a). Local scale:-**We will call the basin, watershed and catchment scales, the local scale'. At that scale, trees take up large quantities of water through their roots and increase infiltration of water into the soil. They use water to grow, and will optimize water use based on its availability: In areas where water input (precipitation) is not a limiting factor, forests will have a limited impact on water quantity, but a large impact on water quality. If water is a limiting factor, trees may have a larger impact on water quantity. **(b). Regional scale:-** The regional scale is the largest scale at which we can realistically manage forest-water interactions.

Evapotranspiration from forested areas is greater than from other vegetation types, and contributes to precipitation downwind, but sometimes reduces local water, since the precipitation generated is deposited outside the catchment. Changes in forest cover in a river basin could significantly impact evapotranspiration, influencing water flows at the regional scale. Managing forests or watersheds, understanding that evapotranspiration processes go beyond the watershed or even the basin, is very important. **(c). Global scale:-** The global scale- or continental scale - is where the long-term and large-scale effects that influence forest evapotranspiration, precipitation and cross-continental transport of atmospheric moisture take place. Forests produce massive amounts of atmospheric moisture- - more than most land cover types - so their cumulative global importance cannot be underestimated.

Optimal density:- It shows how different tree-water interaction vary, depending on forest cover density in this specific landscape. **(a). Open (degraded):-** without trees, surface runoff

and soil evaporation are high, leading to low soil moisture and groundwater recharge, despite low transpiration. **(b). Intermediate:-** With an intermediate canopy cover, low surface runoff and evaporation, as well as intermediate transpiration, optimize soil moisture and groundwater recharge. (c). **Closed:-** In closed forest, despite low surface runoff and soil evaporation, total transpiration and interception are high, again leading to low soil moisture and groundwater recharge.

Forests Are both Water Users and Water Recyclers and Forest-Water Ecosystems

Water saver:-Forests require water in their metabolism, as trees are living organisms, and therefore may reduce streamflow downstream.

Water recyclers:-Forest also contributes to atmospheric moisture and precipitation, groundwater recharge and soil moisture, thereby 'recycling' the water into the water cycle.

Water ecosystem services depend on various factors, such as scale, age or type of forest.

Peatlands depend on the presence of water for peat - organic material - to accumulate. Peatlands are the largest terrestrial carbon sink in the world, making them very important to address climate change. They also provide key habitats for biodiversity, act as natural filters providing good quality water, and can contribute to flood mitigation. When peat lands are drained, for example for agriculture, the peat is exposed and decomposes very quickly. This results in the rapid loss of stored carbon, which contributes to global greenhouse gas emissions. It will also negatively impact the provision of the other services I mentioned. Other examples of forest ecosystems include dryland forests, cloud forests and mangroves.

Benefits from Forest-Water Relationships

Forest-water interactions lead to many benefits, which are also called ecosystem services. They include water purification, carbon storage, protection against environmental hazards and providing habitats for biodiversity. To give a comprehensive explanation of the benefits brought by forest water interactions, we will distinguish between environmental, economic and sociocultural aspects. **Environmental benefits:-** We mentioned earlier that trees and forests contribute to: regulating water quantity and timing, supporting groundwater recharge**,** generating clouds through evaporation from the ground and transpiration from the leaves**,** filtering and purifying water and reducing soil erosion and sedimentation of water bodies. **Economic benefits:-** Wood and non wood forest products, Water for people &

industries, Coastal protection and improved soil. **Sociocultural benefits:-** Spiritual and cultural values, recreational values and social values.

Conclusion

The ability of forests to provide crucial water-related ecosystem services cannot be underestimated. Trees and forest regulate water quality by acting as a natural filter for nutrients, and by reducing soil erosion and sedimentation. Trees and forest regulate quantity and timing by slowing runoff, and increasing infiltration and evapotranspiration. Trees and forests are also crucial for water access in watersheds. They support the provision of accessible fresh water for human consumption and agriculture, and offer many other environmental, economic and sociocultural benefits. Many communities, including indigenous peoples, urban centre and agricultural communities, rely on forest-water relationships for their livelihoods, sustenance and wellbeing. In addition, the spiritual and cultural connections of local communities, such as indigenous peoples, to these ecosystem may form part of their indentify and livelihoods.

References

Bonnesoeur, V., Locatelli, B., Guariguata, M. R., Ochoa-Tocachi, B. F., Vanacker, V., Zhun, M., Stokes, A., & Mathez-Stiefel, S.-L. (2019). *Impacts of forests and forestation on hydrological services in the Andes: A systematic review*. Forest Ecology and Management, 433, 569-584.

Creed, I. F., & van Noordwijk, M. (Eds.). (2018). *Forest and Water on a Changing Planet: Vulnerability, Adaptation, and Governance Opportunities*. A Global Assessment Report.* IUFRO World Series Volume 38. Vienna. 192 pp.

Agroforestry Network. 2020a. Agroforestry and water for resilient landscapes.

Agroforestry Network. 2020a. Agroforestry value chains and market systems.