IUFRO

RESEARCH LETTER

On Forest and Water Interactions

Forest watersheds – clean water resources – water conservation – flood and drought mitigation – hydrology – climate change – groundwater – adaptive watershed management

ENSURING OUR ACCESS TO CLEAN WATER

More than one in six people worldwide do not have access to safe drinking water and approximately 80 percent of the global population is living in areas where water resources are insecure. Forest watersheds play an important role in providing domestic, agricultural and commercial water, and therefore the conservation of forests is key to sustaining the availability and quality of water. Water conservation, soil protection and flood/drought mitigation provided by forests are paramount to human welfare and environmental sustainability.

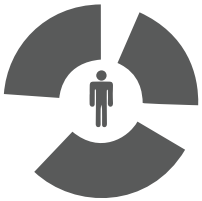
Forests capture and store water by increasing absorption, infiltration, abating runoff velocity and reducing water erosion. Filtration of water pollutants, flow regulation, and the mitigation of floods, droughts and salinity are among other key services of forests related to water.

According to the FAO Forest Resources Assessment 2010, 8 percent of the total forest area worldwide (330 million hectares) are designated for protection of soil and water. This means an increase by 59 million hectares between 1990 and 2010 (which is primarily due to large-scale planting in China for protective purposes).

The quantity and quality of water as well as the accessibility to clean water resources throughout the globe are being threatened by deforestation, land use change, climate change and environmental pollution.

FORESTS AND WATER IN INTERNATIONAL AGREEMENTS

At an international level, the linkage between water, wetlands and forests is addressed in many international instruments and initiatives such as the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, the Ramsar Convention, REDD+ (Reducing Emissions from Deforestation and forest Degradation) and LULUCF (Land Use, Land-use Change and Forestry). The significance of the interactions between forests and water is also embodied in many regional policy goals and initiatives, e.g. the Warsaw Resolution 2 “Forests and Water” of Forests Europe (formerly the Ministerial Conference on the Protection of Forests in Europe). The issue plays an important part in ensuring environmental sustainability, one of the eight UN Millennium Development Goals.



KNOWLEDGE GAPS

The interaction between forests and water at multiple scales, and in varying geographical locations, under different management regimes and in different forest types with diverse species is not fully understood. Although there is a general understanding drawn from numerous small watershed (< 100 km^2) studies that forest change can generate pronounced effects on annual runoff and small to medium-sized floods, the interactions between forest and many other hydrological variables still lack consistent conclusions. For instance, the effects of forests on precipitation, flood regulation and mitigation have been debated.

The traditional view that forests can generate limited effects on large floods based on experimental paired watershed studies has recently been challenged by several studies in British Columbia (Canada). In comparison to a wealth of small watershed studies, large watershed studies (e.g. watershed size > 1,000 km^2) are very limited and inconsistent interactions between forest and water have been reported even for annual runoff, not to mention floods and low flows.

Moreover, there are great difficulties in extrapolating the results from small watersheds to large watersheds. Since many practices and policies of natural resource management are implemented at large landscape, watershed or even regional scales, inadequate scientific information drawn from large watershed studies greatly impedes the development of sustainable watershed management strategies.

Traditional forest hydrology focuses largely on interactions between forest and surface water, while little attention is given to the relationships between forest and groundwater. Groundwater comprises an important component of the water cycle, especially in dry seasons when river runoff is mainly recharged by groundwater. Therefore, there is a clear need to improve understanding of the interactions between surface water, groundwater and forests.

In a context of global climate change, there are more frequent droughts, wildfire, and insect outbreaks, but it is still uncertain how these climate change-induced large-scale forest disturbances will affect the water cycle across different spatial scales. Moreover, the impacts that worldwide large scale afforestation/reforestation projects aimed at mitigating climate change are likely to have on the watershed hydrology at different scales are little known.

The interplay of forest, water and climate change is not fully understood, and thus there is a great challenge in designing adaptive forest management strategies to mitigate the negative effects of climate change on water resources and ecosystem functions.

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IUFRO'S TASK FORCE "FOREST AND WATER INTERACTIONS"

This Research Letter summarizes the findings of IUFRO's Task Force "Forest and Water Interactions" between 2011 and 2014. The group addressed questions such as water consumption of growing tree crops compared to other land uses, and the impacts of bio-energy/reforestation schemes on regional water resources; eco-hydrologic responses of forests to climate change and adaptive forest management strategies ensuring water supplies and other ecological services; and integrated watershed hydrology and landscape management.

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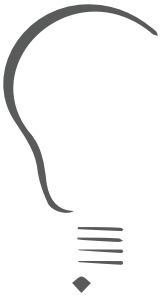

LESSONS LEARNED

The linkages between water, wetlands and forests show the importance of managing ecosystems in their entire complexity in order to protect related vital services. To achieve sustainable land management, landscape managers have the key task of balancing this wide range of multi-sectoral forest benefits without detriment to water resources and ecosystem functions.

In spite of the current knowledge about the interactions between forests and water, we remain unable to accurately predict how different changes in land uses affect regional hydrology and water resources.

Policy makers worldwide have spent enormous efforts and money to develop a number of policies to secure water resources, but many have not worked as expected and some have even made the situation worse. The lack of an integrated assessment framework based on high quality eco-hydrological research accounts for such failures. There is a need to develop a framework assessing the overall benefits and costs of forestry schemes in relation to timber supply, biodiversity, societal and environmental impacts. Water resource costs must be taken into account when assessing the benefits and costs of forestry programs.

Water use of forests is generally higher than that of crops, resulting in reduced annual runoff. Fast growing tree species used for commercial timber production or bio-energy plantations yield more significant reductions in annual runoff than slower growing species or older plantations. Thus, plantation development plans must be designed with a consideration of water use, especially in dry areas, which requires a careful selection of tree species and planting sites to minimize the competition for water between planted forests and humans.

In addition, given the important role of forests in the water cycle, water resource management practices must be performed in line with the natural hydrological pattern and processes, avoiding negative impacts resulting from hydrological alterations due to forest change in the context of climate change. This calls for multi-sectorial collaboration between forestry, land management, and water resource conservation to develop adaptive management strategies of forest, water and land resources.

To address this priority, there is a pressing need for greater understanding of the interactions between forests and water at a landscape level or large watershed scale, for better recognition and capacity strengthening in forest eco-hydrology and adaptive watershed management under a changing environment, and for translating this knowledge into policies and decision-making processes. Issues of governance and institutional arrangements also need to be taken into account, in order to minimize the risks of destroying the water balance.

COMBATING WATER SCARCITY IN LATIN AMERICA

Latin America is one of the water richest regions worldwide, but has suffered from several water crises in the past and climate change is expected to further exacerbate the problem. The region is also facing critical rates of deforestation and forest degradation. Water scarcity is often assumed to be closely linked with poverty, bad sanitation infrastructure and inequality, as well as with extensive droughts – observed in countries such as Argentina, Guatemala and Mexico – and other weather-related disasters. Regional and global efforts in counteracting water scarcity as well as forest degradation and poverty need to address the relationships between water and forests to develop sustainable and appropriate measures. In order to safeguard water resources and access in the long run, we need to highlight and optimize the various environmental services provided by watershed landscapes and ecosystems. This has to be done through adequate landscape and watershed management. For example, water scarcity as a consequence of decreases in precipitation is worsened by the reduced infiltration capacity of degraded sloping environments. Forests and trees can help to keep erosion rates low and to improve the soil's infiltration capacity.

CONCLUSIONS

Forests play a vital role in regulating the water cycle and providing clean water. The interaction between forests and water at multiple scales has to be given higher priority when thinking about ensuring water quality and access to clean water.

The understanding of interactions between forests and water is mainly drawn from small watersheds, which impedes the design of sustainable natural resource management strategies on large spatial and regional scales. Large watershed studies are urgently needed.

There is a dynamic interplay between forests, water and climate change. Forests can be managed to mitigate the negative effects of climate change on water resources and ecosystems, and consequently to ensure a safe and clean water supply and to reduce the risk of floods and droughts.

It is crucial to maximize forest ecosystem services without threatening water resources, especially with regard to climate change mitigation measures.