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47

Water, Wetlands and Forests

A Review of Ecological, Economic and Policy Linkages

Convention on Biological Diversity

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CONVENTION ON WETLANDS
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For further information, please contact:
Secretariat of the Convention on Biological Diversity
World Trade Centre
413 St. Jacques Street, Suite 800
Montreal, Quebec, Canada H2Y 1N9
Phone: +1 514 288 2220
Fax: +1 514 288 6588
Email: secretariat@cbd.int
Website: www.cbd.int

Secretariat of the Ramsar Convention
rue Mauvernay, 28
1196 Gland
Switzerland
Phone: 41 (0) 22 999 0171
Fax: 41 (0) 22 999 0169
E-mail: ramsar@ramsar.org
Website: www.ramsar.org

Editorial assistance: Jacqueline Grekin, Secretariat of the Convention on Biological Diversity
Typesetting: Em Dash Design

Cover photos: Top to bottom: David Coates; Eduardo Augusto Muylaert Antunes–UNEP/Still Pictures, Vlasta Juricek–Flickr.com, Britta Jaschinski–Flickr.com

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FOREWORD

The linkages between water, wetlands and forests exemplify the importance of managing ecosystems in their entirety to protect their ecological character as well as the freshwater resources and related ecological services that are so vital to human activity on Earth. Inland waters are amongst the most threatened ecosystem types of all, and it is estimated that half of the world's wetlands have been lost since 1900. Deforestation is also posing a major threat to water catchments and the quantity and quality of available fresh water. With water use growing at more than twice the rate of population growth, it is vital that we properly understand the linkages between water, wetlands and forests, and manage our ecosystems accordingly.

This Technical Series publication addresses a request by the Conference of the Parties (decision IX/5 3(e)) to examine linkages between the Convention on Biological Diversity and the Ramsar Convention on Wetlands. To provide adequate context, this document summarizes information on the crucial linkages between water, wetlands and forests, and how these linkages are recognized and accounted for in terms of ecology, economics and policy. Based on an analysis of complementarities between both Conventions with regard to forests and wetlands, this publication highlights topical synergies that may benefit from increased collaboration.

We would like to thank our partners who contributed to the development and review of this publication, including the Ramsar Convention on Wetlands, the Food and Agriculture Organization (FAO), Forest Europe, the International Union for Conservation of Nature (IUCN), UN-Water, and the United Nations Educational, Scientific and Cultural Organization (UNESCO). We trust that this publication will provide useful information on this topic and encourage further and strengthened cooperation between the multitudes of stakeholders involved in protecting our planet's freshwater resources and its interdependent ecosystems.

Dr. Ahmed Djoghlaf
Executive Secretary
Convention on Biological Diversity

EXECUTIVE SUMMARY

The ecological linkages between water, wetlands and forests represent the intricate interdependence of our ecosystems and our resources. Forests play a pivotal role in the hydrological cycle by affecting rates of transpiration and evaporation, and influencing how water is routed and stored in a watershed. This consequently plays a vital role in the preservation of our wetlands, which act as natural reservoirs and are extremely rich in terms of both biodiversity and the ecological services that they provide, for example, within the realms of agriculture, sanitation, and energy.

The importance and scarcity of our freshwater resources cannot be overstated; it is estimated that by 2025, 1.8 billion people will be living in regions with absolute water scarcity and two-thirds of the world's population could experience water-stress conditions. There are also crucial economic linkages that need to be understood, such as the water storage function of forests, which can often be significantly higher than the potential timber value of those forests.

Watershed management programmes and payment for ecological service mechanisms have been designed and implemented to help correct some of the market failures that result in actions that are harmful to both the affected ecosystem and economy. From a policy aspect, it is crucial that the linkages between water, wetlands and forests are taken into consideration to adequately protect our water resources and related ecosystems. This holistic approach is highlighted by the Ramsar Convention on Wetlands' "wise use" practices, as well as the Convention on Biological Diversity's "ecosystem approach." The joint work plan between these two conventions signifies both the congruency of their respective approaches as well as the importance of ensuring that the ecological linkages are not neglected in the policy realm.

This document first addresses the issue of freshwater scarcity as an introduction to the importance of forest and wetland linkages. Ecological linkages are then described, with specific note of the hydrological cycle, the results of forest and water ecosystem interaction and human linkages to both ecosystems. The economic linkages are then described, with particular attention given to watershed management programmes and payments for ecological services. Finally, the policy linkages are explored both in a holistic sense through the ecosystem approach, sustainable forest management and integrated water resource management, but also through a policy overview of the Convention on Biological Diversity and the Ramsar Convention on Wetlands, along with a brief review of synergies and gaps between the two conventions.

These linkages highlight the importance of utilizing proper scope to ensure full stakeholder involvement and cooperation across a multitude of sectors when dealing with our planet's water resources. This can be facilitated in part by enhanced collaboration between the Convention on Biological Diversity and the Ramsar Convention on Wetlands to assist their respective member Parties in implementing management policies in accordance with the ecosystem approach and wise use practices.

I. INTRODUCTION

RAISING THE TIDES OF CONSCIOUSNESS AROUND OUR WATER RESOURCES

Water is a simple yet perfect substance that is the cornerstone of life on Earth. Its countless uses allow for our flourishing biodiversity, while its uniformity connects us with the rest of the living world around us. Water is, in itself, a living process—with its same molecules cycling through their different phases to sustain life on Earth. These ancient molecules run through our veins today and will continue to sustain us into the future, provided we take the necessary care to maintain this invaluable resource. The importance of water is apparent, but the current state of this resource is something that must be discussed, understood and acted upon to ensure its sustainability. Proper care can ensure its sustainability, but continued mismanagement and depletion of our water resources will lead to nothing short of a crisis for life on our planet.

While, for many of us, potable water can be obtained at any time of day or night just by turning a faucet, more than one in six people worldwide do not have access to their daily requirement of safe fresh water. It is estimated that by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity and that two-thirds of the world population could experience water-stress conditions. Water use has been growing at more than twice the rate of population growth, with 70% used for irrigation, 22% for industry, and 8% for domestic use. Despite the crucial importance of this resource, we continue to mistreat this reservoir of life. We dump 2 million tonnes of human waste into watercourses each day, and 70% of industrial waste in developing countries is dumped untreated into waters, polluting the usable water supply.

The importance of water and the current plight of this resource are highlighted in the United Nations' Millennium Development Goals. One major target is to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation. Another target aims to achieve a significant improvement in the lives of at least 100 million slum dwellers by 2020, by focusing on improving sanitation and water facilities. Water is also inextricably linked to the target to halve, between 1990 and 2015, the proportion of people who suffer from hunger, since water quality, availability and use are major factors in agriculture and food prices. The target to reduce biodiversity loss also directly incorporates the protection of water resources, both in and of themselves and as part of ecosystems. While the protection of our water resources is highlighted in these targets directly, the importance of fresh water makes its preservation a crucial component of all of the Millennium Development Goals (Figure 1).

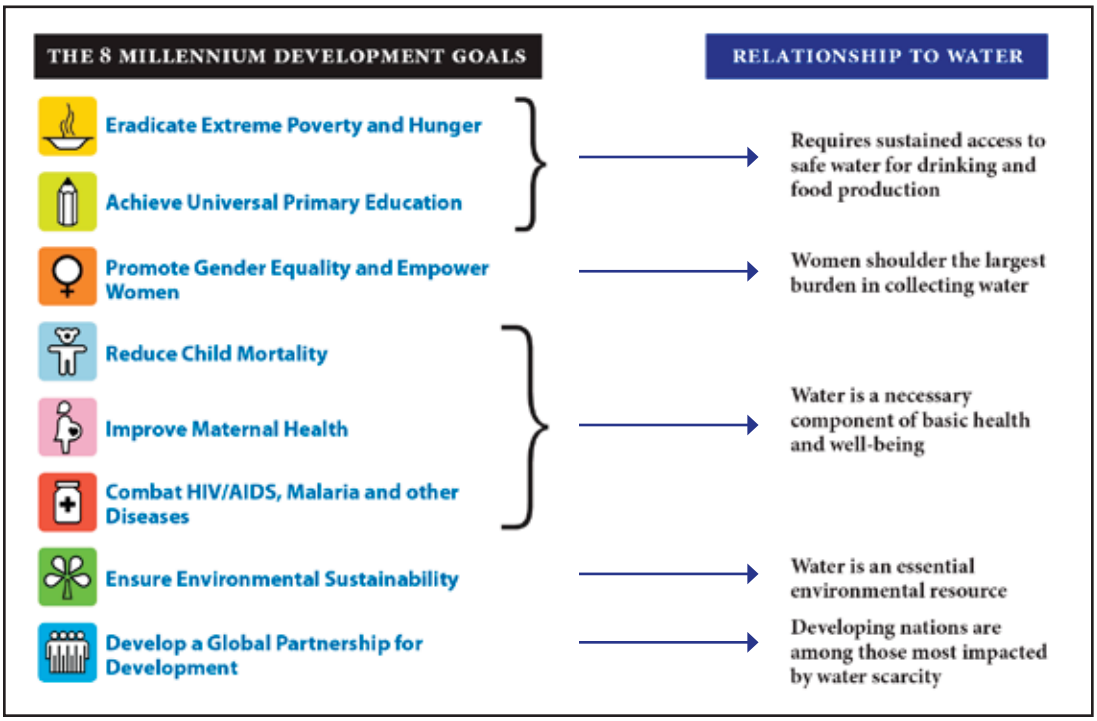

FIGURE 1: Millennium Development Goals
Source: Compiled by authors using original image of the Millennium Development Goals

The increasing awareness of the importance of our freshwater resources has not only pervaded our environmental and public health sectors, it has also reached the business world. "Water Worries" was the theme of a May 2009 Citigroup Global Markets publication.[1] The publication focused on the fact that unsustainable water usage has caused water scarcity to become an economic constraint in major growth markets such as China, India, and Indonesia, as well as commercial centres in Australia and the western United States. It went on to cite the World Economic Forum, which stated:

> *Worsening water security will soon tear into various parts of the global economic system. It will start to emerge as a headline geopolitical issue. (…) We are now on the verge of water bankruptcy.*[2]

This information, coupled with the fact that a survey of Fortune 1000 companies revealed that 40% said the impact of a water shortage would have "severe" or "catastrophic" impacts on their business, indicates that water is a crucial part of both our economic and environmental systems.[3]

It is necessary, however, that we view water not as a mere commodity, but as a vital aspect of our natural ecosystems. It is estimated that half of the world's wetlands have been lost since 1900, and more than 20% of the world's 10,000 known freshwater species have become extinct, threatened or endangered.[4]

1 *Water Worries: Update #2*, Edward M. Kershner and Michael Geraghty, Citigroup Global Markets, 20 May 2009.
2 World Economic Forum. 2009. The Bubble is Close to Bursting: A Forecast of the Main Economic and Geopolitical Water Issues Likely to Arise in the World during the Next Two Decades. Draft for Discussion at the World Economic Forum Annual Meeting, January 2009, p. 5.
3 *Water Worries: Update #2*, Edward M. Kershner and Michael Geraghty, Citigroup Global Markets, 20 May 2009.
4 Fact Sheet on Water and Sanitation, Water for Life. http://www.un.org/waterforlifedecade/factsheet.html

It is therefore crucial to consider the preservation of freshwater resources as an essential component for the preservation of biological diversity, healthy ecosystem function, and biological resources. The Convention on Biological Diversity gives the following definitions for "biological diversity," "ecosystem," and "biological resources," respectively:[5]

> *"Biological diversity" means the variability among living organisms from all sources including,* inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.*
>
> *"Ecosystem" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.*
>
> *"Biological resources" includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.*

We now find ourselves at the crossroads of how we have treated our water resources and their capacity to serve us in the future. We cannot continue our unsustainable practices and further strain the diminishing supply of fresh water. We must heed this call and work towards a better understanding of how to manage our water resources to ensure that our ecosystems will continue to provide us with the vital sustenance that water has granted us thus far, and which we will continue to require indefinitely.

Jacqueline Grekin

5 Article 2. Use of Terms. Convention Text, Convention on Biological Diversity

II. ECOLOGICAL LINKAGES

Water, wetlands and forests are constantly interacting to produce healthy and productive ecosystems. Forests, for example, play a critical role in the well-being and proper function of the hydrological cycle. An examination of the hydrological cycle reveals how forest conservation and management are intimately linked to the health of water basins and the quality of water downstream. Forests also regulate soil erosion and pollution, and prevent desertification and salinization. The capacity of forests to help capture and store water helps to mitigate floods in periods of heavy rain and ensures steady water flow during drier seasons. In return, many forests depend on groundwater for survival, and rely on wetlands to support their flora and fauna. Wetlands also play a critical role in maintaining many natural cycles and supporting a wide range of biological diversity.

THE HYDROLOGICAL CYCLE

We cannot act properly to preserve our water resources without first understanding how water circulates throughout the environment. The same water that we depend on today has been circulated throughout its various forms in the hydrological cycle since water first appeared on this planet. The hydrological cycle describes the movement of water on, above, and below the surface of the Earth as ice, liquid water, and water vapour (Figure 2). This cycle is further influenced by natural processes, such as transpiration from plants and human activities.

The hydrological cycle is the fundamental building block of freshwater resources, which comprise only 2.5% of the total water on Earth. Of these freshwater resources, about 70% is in the form of ice and permanent snow cover, 30% is stored underground, and 0.3% comprises the world's freshwater lakes and rivers. Consequently, the total freshwater supply for use by humans and ecosystems is less than 1% of all freshwater resources and less than 0.015% of all water on the planet.[6] It is this small portion of the Earth's water that we rely on so heavily for food production, industry, drinking water, and the maintenance of healthy ecosystems. Through the hydrological cycle, water is transferred between surface, subsurface and atmospheric regions through the multitude of processes shown in figures 2 and 3.

In brief, water travels from the Earth's surface to the atmosphere as water vapour through *evaporation* (the process of turning water from a liquid to a gas) from surface water and runoff, or *transpiration* through plants. Transpiration describes the movement of water through soil and vegetation, and accounts for 62% of annual globally renewable fresh water (Figure 2). In the hydrological cycle, the results of transpiration are known as "green water," whereas the liquid water moving above and below the ground is known as "blue water." (Figure 3). The vapour accumulated through these processes, together referred to as *evapotranspiration*, represents 10% of the world's fresh water and cycles in the atmosphere in a "global dynamic envelope."[7] This vapour then condenses to form clouds, where it later returns to the Earth's surface through precipitation. Precipitation is the main source of fresh water, after which the water either returns to the atmosphere through evaporation or transpiration, recharges groundwater, or provides surface and subsurface runoff, which ultimately flows into larger bodies of water.[8]

6 UN Water Statistics, http://www.unwater.org/statistics_res.html

7 UNESCO Water Portal bi-monthly newsletter No. 213

8 World Water Assessment Programme. 2009. *The United Nations World Water Development Report 3: Water in a Changing World.* Paris: UNESCO, and London: Earthscan, pp. 166-7. http://www.unesco.org/water/wwap/wwdr/wwdr3/.

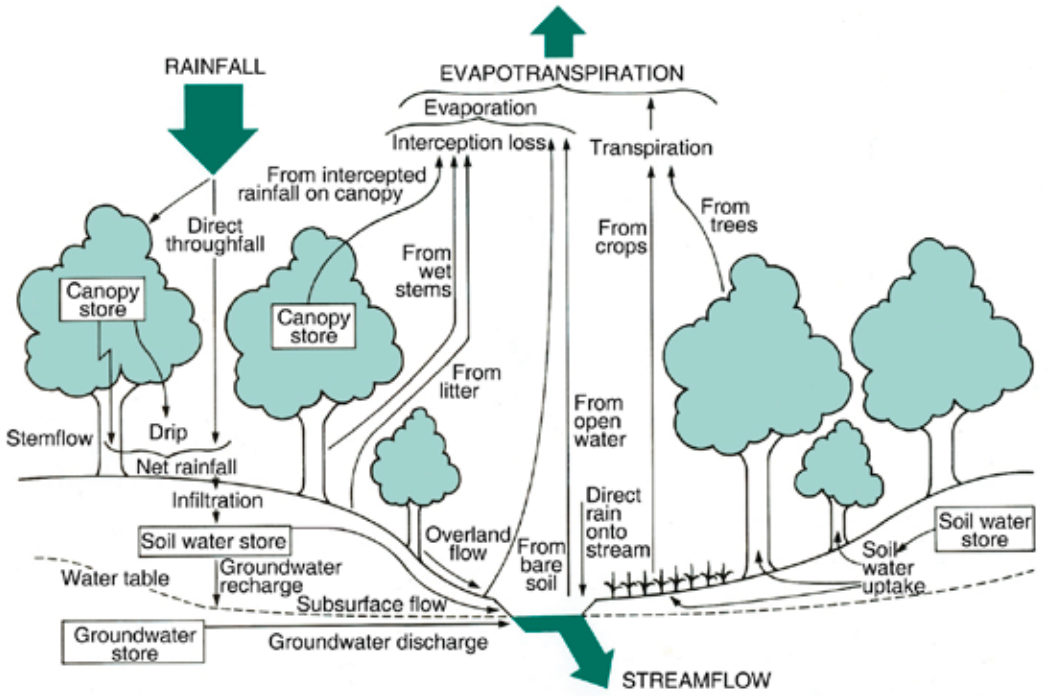

FIGURE 2: The hydrological cycle

Source: L. S. Hamilton 2008. Forests and Water. *FAO Forestry Paper 155, Rome: FAO, 3.*

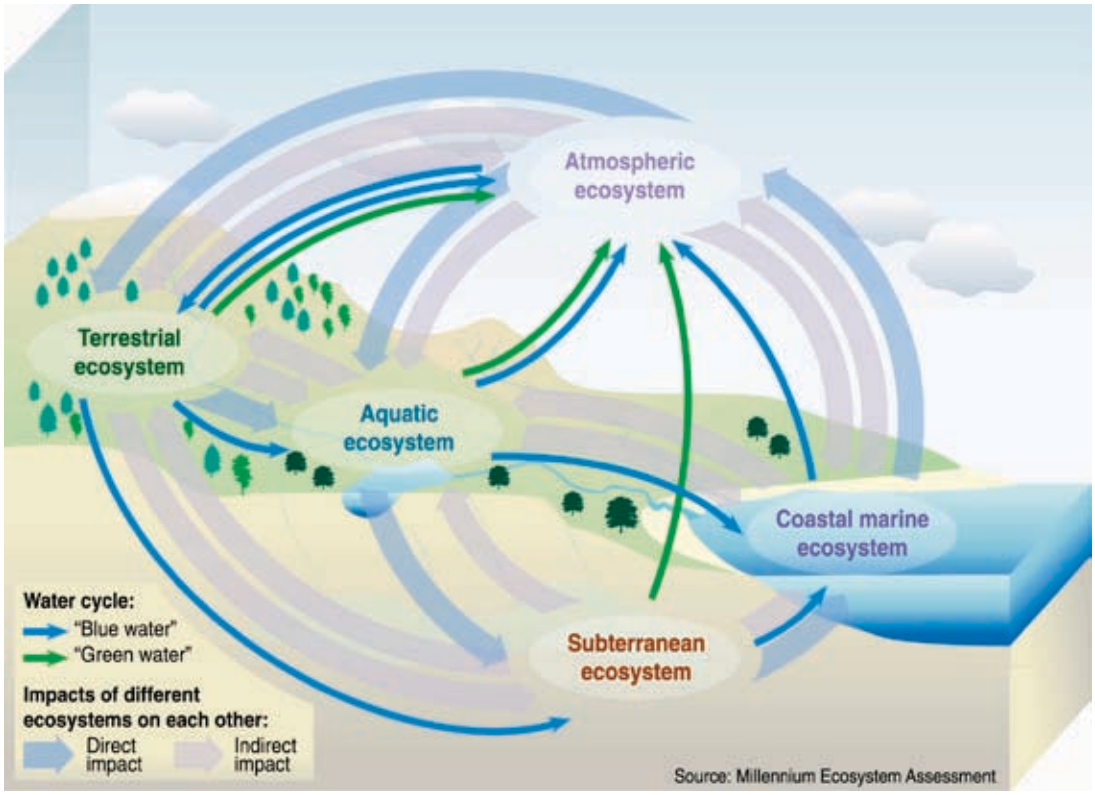

FIGURE 3: Interrelations among environmental components of the global water cycle

Source: Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Wetlands and Water Synthesis. World Resources Institute, Washington, D.C.

RESULTS OF FOREST AND WETLAND ECOSYSTEM INTERACTION

Given the crucial importance of water to life on Earth, it is necessary to consider how various ecosystems are linked through the hydrological cycle. One key example is the relationship between forests and wetlands. Far too often, these interdependent ecosystems are viewed as completely separate entities instead of a linked unit that plays a crucial role in the hydrological cycle and the preservation of our water resources. A better understanding of the role that these bodies play in the hydrological cycle will enable us to more effectively consider these ecosystems when formulating policies and management practices to protect our water resources.

BOX 1: Forests and Water: Key Messages for Policy-makers

WATER USE BY FORESTS
Factors influencing water use by forests include climate, forest and soil type, among others. In general, forests use more water than shorter types of vegetation because of higher evaporation; they also have lower surface runoff, groundwater recharge and water yield. Forest management practices can have a marked impact on forest water use by influencing the mix of tree species and ages, the forest structure and the size of the area harvested and left open.

DRY-SEASON FLOWS
Forests reduce dry-season flows as much or more than they reduce annual water yields. It is theoretically possible that in degraded agricultural catchments the extra infiltration associated with afforested land might outweigh the extra evaporation loss from forests, resulting in increased rather than reduced dry-season flows—but this has rarely been seen.

FLOOD FLOWS
Forests can mitigate small, local floods but do not appear to influence either extreme floods or those at the large catchment scale. One possible exception is reduction of downstream flooding by floodplain forest, where hydraulic roughness (the combination of all elements that may cause flow resistance, such as forest litter, dead wood, twigs and tree trunk) may slow down and desynchronize flood flows.

WATER QUALITY
Natural forests and well-managed plantations can protect drinking-water supplies. Managed forests usually have lower input of nutrients, pesticides and other chemicals than more intensive land uses, such as agriculture. Forests planted in agricultural and urban areas can reduce pollutants, especially when located on runoff pathways or in riparian zones. However, trees exposed to high levels of air pollution capture sulphur and nitrogen and can increase water acidification.


André Duchesne

EROSION
Forests protect soils and reduce erosion rates and sediment delivery to rivers. Forestry operations such as cultivation, drainage, road construction and timber harvesting may increase sediment losses, but best management practices can control this risk. Planting forests on erosion-prone soils and runoff pathways can reduce and intercept sediment.

CLIMATE CHANGE
Global climate models predict marked changes in seasonal snowfall, rainfall and evaporation in many parts of the world. In the context of these changes, the influence of forests on water quantity and quality may be negative or positive. Where large-scale forest planting is contemplated for climate change mitigation, it is essential to ensure that it will not accentuate water shortages. Shade provided by riparian forests may help reduce thermal stress to aquatic life as climate warming intensifies.

ENERGY FORESTS
Fast-growing forest crops have potential for high water demand, which can lead to reduced water yields. The local trade-off between energy generation opportunities and water impacts may be a key issue in regions where climate change threatens water resources.

Source: IUFRO 2007. How do Forests Influence Water? *IUFRO Fact Sheet No. 2, cited by I. Calder, T. Hofer, S. Vermont and P. Warren 2007. "Towards a new understanding of forests and water." Unasylva 58 (229). Rome: Food and Agriculture Organization.*

Forests play a very important role in the hydrological cycle by directly affecting rates of evapotranspiration and by influencing how water is routed and stored in a watershed. Forest soils readily absorb water and, as a result, surface runoff rarely occurs outside of stream channels in forested areas, causing important water catchments to form beneath forests.[9] These catchments not only help store valuable fresh water, but they also increase the quality of water since forest cover reduces erosion and keeps rainwater within the enriched soil of forest beds and away from pollutants. Other aspects of the role that forests play with respect to water are expanded in Box 1.

As a result of the key role that forests play both in the hydrological cycle and in the natural supply of fresh water, it is no surprise that a recent review revealed that about one-third of the world's largest cities obtain a significant portion of their drinking-water directly from forested protected areas. The proportion increases to about 44% when including water sources originating in distant protected forested watersheds and other forests managed in a way that prioritizes their functions in providing water.[10]

Coastal ecosystems are among the most productive in the world, and have strong linkages to both habitats and settlements that extend beyond their importance in the hydrological cycle. Forested riparian wetlands, for example, play a vital role as buffers to ameliorate the impacts of floods. The wetlands along the Mississippi River had the capacity to store about 60 days of river discharge, but their removal to create canals and levees has reduced flood storage capacity to only 12 days of discharge—a reduction of 80%.[11]Forested wetlands also have tremendous value with regards to their biodiversity since the varying habitat types result in a significant array of biological communities. One prime example of the unique biodiversity that results from forested wetlands is the relationship between trees and fish in the flooded forests of the Amazon. At least 200 different species of fish have developed molars to crush seeds, nuts, and fruit, and these fish, in turn, help to disperse the trees' seeds[12] (Box 2).

Forest mismanagement can have adverse implications on water quality and biological diversity in both the forests and the nearby wetlands, and mismanagement of wetlands can adversely impact the surrounding forests. It is therefore imperative that policy-makers consider ecosystems in their entirety to properly account for the impacts that management and practices will have throughout the ecosystem. This approach was highlighted in a 2002 meeting of international experts held in Shiga, Japan.

BOX 2: The Tambaqui

The tambaqui (*Colossoma macropomum*) is uniquely adapted to the flooded forests of the Amazon. It feeds on seeds and fruit for most of the year, a practice that has yielded significant adaptations in both the plants and fish in the area. The tambaqui has developed molars to help crush fruit and seeds, as well as nasal flaps to help it find fallen fruit in the water. Since many trees rely on these fish to disperse their seeds, they have evolved to make their fruit easy for the fish to find by producing fragrant oils, resins, latexes, and acids that attract the fish. Some other fish species spit out the seeds intact or defecate them whole in a new location where they can then grow into new trees.

Source: Encyclopedia Britannica, Piranha, Supplemental Information http://www.britannica.com/EBchecked/topic/461541/piranha/461541suppinfo/Supplemental-Information

Graif Gestell/Flickr.com

9 Pike, Robin. Forest Hydrologic Cycle Basics. *Streamline Watershed Management Bulletin*, 7(1) 2003, 1–5

10 Stolton, S., and Dudley, N. Managing forests for cleaner water for urban populations. *Unasylva*. FAO. 229. 40–1.

11 Millennium Ecosystem Assessment, 2005: *Ecosystems and Human Well-Being: Wetlands and Water*. Island Press, Washington, DC.

12 Adlon, Jacob. Flooded Forests of the Amazon. Associated Content. 30 April 2009. http://www.associatedcontent.com/article/1690185/flooded_forests_of_the_amazon.html?singlepage=true

The purpose of the meeting was to contribute to the discussion and outcomes of the upcoming Third World Water Forum. About 100 forest and watershed management experts from 18 countries and 16 international organizations and NGOs met in Shiga, Japan under the organization of the Forestry Agency of Japan and the Shiga Prefectural Government. Among its recommendations, the group declared the following:

> *Effective forest and watershed management are valuable for long-term sustainability of water resources. Governments and other stakeholders should develop policies and implement programmes that promote holistic, multi-disciplinary and multi-stakeholder approaches that link forests, water, watersheds, the environment and people*.[13]

HUMAN LINKAGES

Human actions may not only drastically alter their own immediate environment, but impacts may be felt in other areas as well as a result of the ecosystem linkages. This is important to consider with regards to forests and wetlands because of the nature of upstream/downstream relations and how that impacts water resources.

Fernando Cavalcati/Flickr.com

Deforestation in the Amazon for cattle farming

The actions taken by upstream forest managers may greatly impact communities living downstream in terms of water resources, flooding, and erosion. As a result, great strides have been made in many areas to ensure "hydrosolidarity" between upstream forest managers and downstream water users. The government of Costa Rica, for example, has sponsored mechanisms to create economic incentives for conserving forests and to compensate those whose land or land uses generate environmental services.[14] Such arrangements are vital to ensure that upstream dwellers can benefit from their natural resources without jeopardizing the ecological safety of resources for downstream users.

If, for example, upstream foresters were to cut down their trees to sell the timber, downstream users would suffer from decreased water quality, lower catchments, and increased flooding and erosion. It is therefore very important to consider interactions between various communities and the impacts that their actions have on the ecosystems around them (Box 3).

Human actions in forests and wetlands also have impacts that extend beyond the hydrological cycle and alter both the surrounding ecosystems as well as the role of humans in that ecosystem. Deforestation in the Amazon flood plains, for example, has decreased the fish available for food.[15] Perhaps more

13 Shiga Declaration, 2002

14 Calder *et al.* 2007. "Towards a new understanding of forests and water." *Unasylva* 229. Food and Agricultural Organization of the United Nations.3-10.

15 Simons, Marlise. "In the Quiet World of Fruit-Eating Fish, a Biologist Feels Too Alone." *New York Times*. 2 February 1988


SomosMedicina/Flickr.com

Anopheles sp.

alarming is the impact that deforestation in other parts of the world is seen to have on Malaria—the most prevalent cause of death in the world.[16] An article in Newsweek noted that the rise in Malaria "can be ascribed almost entirely to human acts of deforestation, which produces stagnant pools of water and allows more sunlight to reach water surfaces."[17] These human-created environments resulting from deforestation create perfect nurseries for *Anopheles* mosquitoes that can then transfer the mosquito parasite to humans—whereas prior to the deforestation, these mosquitoes made up an insignificant part of the ecosystem. A study found that an increase in human-biting rates of the *Anopheles* mosquito was directly correlated to deforestation—even after controlling for the presence of humans.[18] This exemplifies the great impacts that humans can inadvertently have on the ecosystems around them and how those changes can, in turn, have deadly consequences for human populations as well as other aspects of the ecosystem. What is perhaps most worrisome is that this does not appear to be an isolated incident, but a trend that is arising as decreasing biodiversity gives way to more deadly pathogens with less competition from nonvector species that had previously kept them in check—exemplified by viruses such as SARS, HIV, and West Nile.[19]

BOX 3: Deforestation in Zambia

Zambia is a landlocked country in southern Africa that lies mainly in the Zambezi River basin and partially in the Congo River basin in the north. A 2007 survey concluded that local communities had been exposed to extreme climactic variations in the past nine years, including droughts, floods, extreme heat waves, and a shorter rainy season.

Deforestation is advancing in Zambia at 3,000 km^2 per year, and has resulted in localized flooding, increased erosion, reduction in surface and groundwater availability, and loss of aquatic life. Decreasing surface and groundwater quality has also been attributed to increasing nutrient load, industrial and agricultural pollutants, and a falling groundwater table.

In the case of Zambia, there are enough water and land resources to facilitate development, but a lack of information and management are damaging the country's water resources and may pose serious challenges in the future. These challenges are directly related to the country's current public health needs, which stem from water-related diseases such as malaria and diarrhea, and a lack of sanitary conditions, which currently claim lives and reduce productivity.


Ilona Bryan/Flickr.com

Exposed tree roots due to erosion

Source: "Zambia: the Zambezi and Congo river basins" in World Water Assessment Programme. 2009. The United Nations World Water Development Report 3: Case Study Volume: Facing the Challenges. *Paris: UNESCO, and London: Earthscan, 15-18. http://www.unesco.org/water/wwap/wwdr/wwdr3/case_studies/pdf/WWDR3_Case_Study_Volume.pdf*

16 Huang, Lily. "Rise of the Bugs." *Newsweek*. 29 June 2009

17 Ibid.

18 Vittor *et al.* The effect of deforestation on the human-biting rate of *Anopheles Darlingi*, the primary vector of Falciparum malaria in the Peruvian Amazon. *American Journal of Tropical Medicine and Hygene*. 74(1), 2006. pp 3-11

19 Huang, Lily. "Rise of the Bugs." *Newsweek*. 29 June 2009

III. ECONOMIC LINKAGES

In recent years, there has been increasing recognition of the ecological services provided by forests and wetlands. Although these services are often essential to economic development, their economic value is sometimes overlooked. Many areas supplying these ecological services remain threatened as a result of poor management and unsustainable use, resulting in environmental degradation. When ecosystems are threatened, their ability to provide ecological services is diminished. This often comes at the cost of local communities that rely most heavily on products obtained from their surrounding environment.

Of the ecosystem services identified in the Millennium Ecosystem Assessment,[20] regulating services, provisioning services, supporting services and cultural services, UNEP has identified 11 as being of critical importance and lying within its mandate (Box 4).

Policies that seek to manage water and forest resources may benefit from accounting for the direct and indirect economic value of ecological services. There also needs to be recognition of the intimate linkages between different sectors of forest and wetland ecosystems. Negative impacts on one sector are likely to harm other sectors of the ecosystem and augment losses in ecosystem goods and services.

WATERSHED MANAGEMENT PROGRAMMES

As a result of the increased awareness of both human and ecosystem linkages between water, wetlands and forests, many watershed management programmes aim to protect watersheds via the protection of forests. This ecosystem approach is highly advantageous to conventional infrastructure approaches which often have adverse effects on the surrounding forest and wetland environments (Figure 4).

One of the most prominent watershed management programmes was created in New York City in 1997 (Box 5); similar programmes have been implemented all over the world. Tokyo and Sydney are examples of two other large cities that have chosen to preserve water quality

20 Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC

BOX 4: Ecosystem Services

REGULATING SERVICES *are defined as the benefits obtained from the regulation of ecosystem processes. They include the following:*

Climate Regulation
Ecosystems influence climate both locally and globally. At the local scale, changes in land cover can affect both temperature and precipitation. At the global scale, ecosystems play an important role in climate either by sequestering carbon (e.g., in forests, grasslands and marine ecosystems) or by emitting greenhouse gases (e.g., forests destruction by fire and melting permafrost). Forests, and the services they provide, are particularly vulnerable to overexploitation and habitat degradation.

Natural hazard regulation
Healthy ecosystems provide protection from extreme events such as hurricanes, tsunamis, high tides, floods, droughts, etc. For example, mangroves and coral reefs help protect coastal areas from storm surges; vegetation cover on a hillside can help prevent erosion and mudslides. Natural disaster and post-conflict response is another key area for results in the UNEP medium-term strategy, and has strong linkages to ecosystem management.

Water regulation
Water scarcity is increasingly affecting human well-being and making us aware of the importance of healthy terrestrial ecosystems as the major source of accessible, renewable fresh water (in itself a top priority service). Ecosystems supply, store and retain water in watersheds and natural reservoirs; they regulate the flow of water required for irrigation and industry, and provide protection against storms, erosion and floods.

Water purification and waste management
Water purification and waste treatment are facilitated by healthy ecosystems, providing clean drinking water and water suitable for industry, recreation and wildlife. Natural wetlands can process and filter pollutants such as metals, viruses, oils, excess nutrients, and sediment. Forests retain water and slowly filter it through the ground.

Disease regulation
Healthy soils and wetlands can trap and detoxify pathogens and regulate disease-carrying organisms. By breaking down human and ecosystem

cont'd p. 17

Box 4 (cont'd)

waste, many organisms reduce the threat of diseases such as cholera. Predatory organisms keep a population of pathogens and its carriers relatively low. Therefore, reducing predator populations, as a result of habitat fragmentation or competition from invasive species, can increase human and other diseases. Recent research has demonstrated that the risk of Lyme disease decreases when the diversity of vertebrate communities is high.

PROVISIONING SERVICES *are the products obtained from ecosystems. These include food, fresh water, wood, fibre, genetic resources and medicines. Of particular interest to UNEP are:*

Fresh water

The well-being of both ecosystems and humans is strongly dependent on this vital ecosystem service, which provides people with water for domestic use, irrigation, power generation, and transportation. The natural availability of fresh water in rivers, lakes and other aquifers varies considerably, however, and demand has exploded over the last century. This has led to the construction of dams, irrigation channels, river embankments and inter-basin canals, often at the cost of ecosystem degradation.

Energy

This ecosystem service was mentioned as 'biomass energy' in the Millennium Ecosystem Assessment. The increased production of biofuels to replace such fossil fuels as wood and charcoal—of particular importance to poor people—has provoked keen debate about the potential impacts of this production on ecosystem and human well being. Hydropower as a low carbon energy source is dependent on freshwater related ecosystem services (provided, for example, by dams) and can also have major impacts on upstream and downstream ecosystems.

Fisheries

Marine and freshwater fisheries are in decline, in spite of increasing demand. Fish protein is of particular importance to poor people. Overfishing is the main problem, but keeping aquatic ecosystems healthy can help sustain populations in the face of growing demand.

SUPPORTING SERVICES *are necessary for the production of all other ecosystem services. Not surprisingly, these relate to fundamental environmental processes and intangible values. Their impacts are either indirect or occur over a very long time. Examples of supporting services include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat. UNEP will focus on two in particular:*

Nutrient cycling

Approximately 20 nutrients essential for life, such as nitrogen, phosphorus and calcium, are absorbed, retained and recycled by ecosystems. Phytoplankton—microscopic plants—in lakes, rivers and the sea absorb nutrients from runoff and pass them up the food chain. Soil organisms—from microbes and fungi to earthworms and insects—are crucial to the chemical conversion and physical transfer of essential nutrients to higher plants. In simplified low-diversity agricultural landscapes, this capacity is much reduced. Many parts of the world suffer from inadequate nutrients in their soils and food, while others must deal with excessive nutrients leading to overload and eutrophication (depletion of oxygen in the water).

Primary production

The life-sustaining production of organic compounds, mainly through photosynthesis by green plants and algae, is known as primary production. All life on Earth relies directly or indirectly on primary production, yet we know very little about its natural limits or its risk of collapse under increasing pressure from climate change and other environmental factors.

CULTURAL SERVICES *is the umbrella term used for the non-material benefits that people obtain from ecosystems, such as spiritual enrichment, intellectual development, reflection, religious experience, and recreation. It comprises knowledge systems, social relations, aesthetic values and appreciation of nature. Of these varied services, ecotourism is of particular interest to UNEP.*

Recreation and ecotourism

Healthy ecosystems which offer opportunities for outdoor recreation and nature-based tourism are becoming an increasingly important economic resource. Far beyond providing an aesthetic experience only for the privileged, ecotourism has great potential and proven success in many parts of the world for alleviating poverty and improving human well-being.

Source: UNEP. 2009. Ecosystem Management Programme—A New Approach to Sustainability. *Nairobi, UNEP Division of Environmental Policy Implementation, 4-8.*

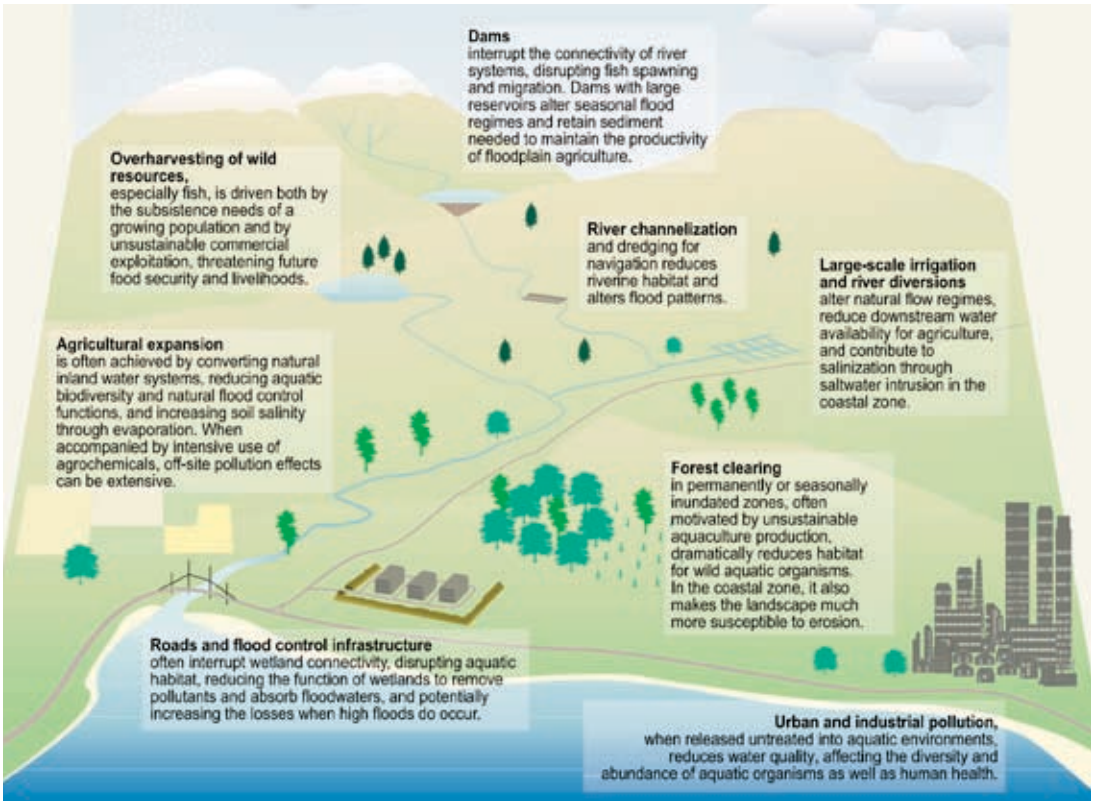

FIGURE 4: Pictorial representation of some direct drivers of change in inland and coastal wetlands
Source: Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Wetlands and Water Synthesis. World Resources Institute, Washington, D.C.

BOX 5: New York City's Watershed Management Programme

One of the best-known examples of watershed management programmes is the case of New York City's plan to protect its water quality to comply with the federal Safe Drinking Water Act. The law required the filtration of drinking water coming from surface water sources unless the water system provided safe water and was actively protected to ensure future water safety. Faced with this new legislation, New York City had to choose between creating a massive filtration system for over nine million people at an approximate cost of US$ 4–6 billion or creating an integrated water resource management approach to protect the Catskill/Delaware watershed at an approximate cost of US$1 billion.


Meena Kadri/Flickr.com

Catskills

The city chose to produce a watershed management programme which included foresters, landowners, farmers, government officials, technical agencies and businesses to help sustain and manage the quality of the largest unfiltered water supply in the United States. The programme balanced economic growth in the Catskills with drinking water protection in NYC by ensuring that the needs of stakeholders were met, while simultaneously meeting applicable drinking water standards. Approximately 95% of watershed farmers have chosen to voluntarily participate, providing for 275 miles of protected stream buffers and 307 site-specific forest management plans on private lands.

Source: United Nations Environment Programme. New York City's Watershed Management Programme. http://www.unep.org/GC/GCSS-VIII/Doc.Inno%20(61-3)%20USA%20Sanitation%205.doc. Retrieved July 22, 2009.

BOX 6: The Panama Canal and Water Quality

Sedimentation and growth of water weeds create problems for shipping in the Panama Canal and require expensive dredging. An adequate, regulated supply of fresh water is also needed. The role of forests in both these issues is recognized by the Smithsonian Tropical Research Institute in Panama, which has recommended reforestation of denuded parts of the watershed. This would reduce not only sedimentation, but also the flow into the canal of nutrients that stimulate aquatic vegetation growth. Reforestation would decrease total water inflow, but the regulated effect of reducing peak flows could result in more useful water, requiring less water storage. It has been proposed that companies dependent on the canal buy bonds to pay for the reforestation.

Lyn Gately/Flickr.com

Panama Canal

In the meantime, a US$ 10 million debt-for-nature swap over 14 years through The Nature Conservancy (which is pledging US$ 1.6 million) is strengthening the protection of existing forest watershed land. This involves 129 000 ha in biodiversity-rich Chagres National Park. The watershed also provides drinking-water for Colón and Panama City.

Source: Plant Talk, 2003, Science and Technology: environmental economics, No. 34, cited in L. S. Hamilton 2008. Forests and Water. FAO Forestry Paper 155, Rome: FAO, 17.

by protecting their forests, which is proving to be both environmentally and economically beneficial.[21] The case of Panama (Box 6) shows how watershed management is vital for industry as well as drinking water, and how innovative finance mechanisms can be used in the place of direct government intervention.

In addition to preserving watersheds for large cities, watershed management has also been used successfully on a smaller scale. Salem, Oregon, for instance, instituted the "Free Tree Program" in 2003 to promote watershed stewardship throughout the city to help improve water quality. Through this programme, streamside property owners can receive free native tress or shrubs to be planted along a waterway on their property. By improving the riparian zone, landowners can, through this programme, reduce stream bank erosion, improve water quality and support biodiversity.[22]

Dean Cully/Flickr.com

Mudslide

21 Stolton, S., Dudley, N. "Managing forests for cleaner water for urban populations." *Unasylva* 229 (58). FAO. 2007. 39-43.

22 City of Salem, www.cityofsalem.net

PAYMENTS FOR ECOLOGICAL SERVICES

The examples discussed in the previous section explain how properly maintaining watersheds and riparian zones is beneficial for both the environmental and economic interests of an area. With this in mind, a finance mechanism is emerging to encourage these practices to preserve our vital natural resources and the ecological services that they provide. This concept is known as "payments for ecological services" (PES).

In 1997, Robert Costanza et al. published an article in *Nature* about the value of the world's ecosystem services and natural capital. The premise was that the services provided by ecological systems contribute to human welfare and therefore represent part of the total economic value of the planet. While PES mechanisms pre-dated Costanza's article, this was an important measure to attempt to properly align the science with the economics. An estimated economic value of 17 ecosystem services for 16 biomes resulted in a range of US$ 16-54 trillion per year, with an average of US$ 33 trillion per year—compared to a global gross national product total of around US$ 18 trillion per year at the time—putting ecological services at a value around twice that of global gross national product.[23]

While these numbers are controversial and hard to gauge precisely, it is clear that ecological services do represent a tremendous economic value that is often not factored into our economic system. PES provides a mechanism by which the values of the services provided can be accounted for, rather than neglected in favour of short-term gains from exploitation that amount to far less than the value of the ecosystems that are destroyed. One example of the market failure that results when proper accounting mechanisms are not put into place lies in the forests of China, which have a water storage function worth about US$ 1 trillion—three times the value of the wood in those forests—and yet deforestation is still a major issue in the nation. Uganda also presents a prime example of this failure of the market to recognize the value of ecological services, since the reduction of water resources due to climate change

Alan Ye/Flickr.com

Xixi National Wetland Park, China

23 Costanza, Robert, et al. "The value of the world's ecosystem services and natural capital." *Nature*, 387. 15 May 1997. 253-280.

has weakened hydropower generation which, in turn, has resulted in increased deforestation as people turn to wood fuels for energy—further damaging the water supply in the region.[24]

The problem with many regulations of land-use practices designed at protecting watersheds is that they place a disproportionate share of the conservation costs on upstream land users without giving them corresponding access to benefits. In response to this, PES provides a market-based arrangement in which upstream land users can recover the costs of maintaining forest cover and be incentivized to protect the watershed. Varying geographies, cultures, and demands make it necessary to implement specifically tailored mechanisms in different areas, and PES initiatives may range from informal, community-based initiatives, through more formal, voluntary contractual agreements between individual parties, to complex arrangements among multiple parties facilitated by intermediary organizations.[25]

Many PES mechanisms have been started in Latin America. Box 7 describes a case in which a forestry financing fund was set up in Costa Rica to compensate forest owners for protecting fresh water, biodiversity, landscape beauty, and carbon storage. The World Bank has helped finance many of these operations, with completed projects in Costa Rica, Colombia, and Nicaragua; projects under implementation in South Africa, Lesotho, Mexico, Kenya, Costa Rica, and Panama; and projects under preparation in Brazil, Colombia, Kenya, Mexico, and Ecuador.[26]

BOX 7: Costa Rica's National Forestry Financing Fund

The Fondo Nacional de Financiamiento Forestal (FONAFIFO; National Forestry Financing Fund) compensates forest owners who adhere to approved management plans for services protecting fresh water, biodiversity, and landscape beauty and for carbon storage. FONAFIFO is financed by selling these services to different types of buyers. Hydroelectric companies and municipalities may pay for watershed benefits, tourism agencies for landscape beauty, and foreign energy companies for carbon storage. Additional funds are derived from a fuel tax. The programme has been in place since 1998, building on lessons learned and institutions established for an earlier ten-year payment for reforestation programme (Pagiola, 2002). FONAFIFO has expanded its range of activities, most recently in 2002, when agroforestry and indigenous reserves were added (Rosa et al., 2003).

A recent assessment of FONAFIFO's social impacts in the Virilla watershed found it has had significant benefits in terms of strengthened capacity for integrated management of farm and forest resources, and has contributed to the protection of 16 500 ha of primary forest, sustainable management of 2 000 ha and reforestation of 1 300 000 ha, with spin-off benefits for biodiversity conservation and prevention of soil erosion. There are also high opportunity costs, however, particularly for smaller landowners, who tend to rely more heavily on small areas of cleared forest and to combine forestry with other activities such as shelter for cattle and shade coffee. Farmers with larger tracts receive greater advantages because they are able to maintain higher proportions of their land in forest.

Source: Miranda, M., Porras, I.T. and Moreno, M.L. 2003. The social impacts of payments for environmental services in Costa Rica : a quantitative field survey and analysis of the Virilla watershed, *London, IIED. cited by Hamilton, L. S. 2008. Forests and Water. FAO Forestry Paper 155, Rome: FAO, 63.*

While PES certainly offers a promising market-based solution for preserving ecosystems, it is by no means perfect. It has proven very difficult to demonstrate and quantify the actual benefits of the services to those who are asked to pay for them, and it is extremely difficult to create a mechanism that is based on both proper scientific measurement of the impact of the policies and reliable valuation of the benefits of these impacts. Nevertheless, the emergence of these new finance mechanisms takes note of the important interactions within and between different topic areas (such as forests and water), and provides an interesting new market-based technique to more properly account for vital ecological services.

24 Kafeero, F. "The impact of water shortage on forest resources – the case of Uganda." *Unasylva* 229 (58). FAO. 2007. 38.

25 Hamilton, L. S. 2008. *Forests and Water*. FAO Forestry Paper 155, Rome: FAO, p. 60-1

26 World Bank, Environmental Economics & Indicators, Payments for Environmental Services, Current Projects, www.worldbank.org

IV. POLICY LINKAGES

Given the linkages between water, wetlands and forests, ideal management policies need to be holistic and adaptable. There needs to be recognition of the fact that all facets of a local ecosystem are connected and that policies affecting one facet will almost inevitably affect another (Box 8). Such holistic policies require an understanding of the local environment, taking into account that each case offers unique opportunities and challenges. A tailored and flexible approach is required to best manage forests and wetlands, as blanket management policies may fail to account for the unique needs of each ecosystem and therefore result in a less optimal outcome.

HOLISTIC APPROACHES

As a result of the inherent linkages between water, wetlands and forests, three major holistic approaches have emerged: the ecosystem approach, sustainable forest management, and integrated water resources management.

The ***ecosystem approach*** (EA) to forest and water management encourages policy-makers to adopt a more encompassing and holistic approach when dealing with ecosystem management[27] (Box 9).

Current forest management policies are largely guided by ***sustainable forest management*** (SFM). At the heart of sustainable forest management lies the goal of ensuring that the flow of goods and services currently derived from forests can be sustained over the long-term.

More recently, there has been a move towards the adoption and implementation of ***integrated water resources management*** (IWRM), which advocates the coordinated development and management of water, land, and related resources in order to optimize social and economic welfare outcomes (Box 10). Currently supported by the World Bank, the Asian Development Bank and the European Union Water Framework Directive (EU WFD)[28], integrated water resources management is another policy approach that signals the increasing need for a holistic approach to environmental management[29].

27 Convention on Biological Diversity, COP decision VII/11—Ecosystem Approach

28 Integrated Water Resources Management Organization, www.iwrm.org

29 Sustainable Management of Water Resources: The Need for a Holistic Ecosystem Approach. Ramsar COP 8 DOC.32 October 2002

BOX 8: Conservation for Downstream Water Flows—Pangani Basin, Tanzania

The Pangani River originates from a 43,000 km^2 basin in northeastern Tanzania and a small section of Kenya. Fourteen districts and two municipalities fall within the basin, which includes the Kilimanjaro, Manyara, Arusha, and Tanga regions of Tanzania. Much of the river flow originates from Mount Kilimanjaro and Mount Meru. The Pare and Usambara Mountains to the northeast also serve as sources for river water. While numerous tributaries drain the highland and upper basin areas, water is much more scarce in the arid lowland areas, making the Pangani River a prominent feature in the landscape. The 14,000 ha Nyumba ya Mungu Dam and several small natural lakes are located in the upper basin of Pangani River. Several wetlands are also found in the basin—most notably the Kirua swamps of Nyumba ya Mungu, which cover 90,000 ha.

Densely populated and cultivated rural areas occupy the highland and upper basin of the Pangani, while scattered croplands dot the lower areas. It is estimated that a total of 2.6 million people inhabit the Pangani River Basin—a population which is set to steadily grow in the coming years.

The Pangani River Basin serves as an excellent example of the intimate links between forest and wetland conservation. While much of the river's water supply comes from precipitation, natural forest cover encourages the infiltration of water during the rainy season. This water is then released gradually, allowing for regular water flows throughout the year. When forest and vegetation cover is degraded, there is less water infiltration. As a result, more water is lost during flood periods. Removal of vegetation also increases the rate of erosion and pollution, both of which affect the quality of water further downstream.

THE SITUATION

Water supply in the Pangani River basin is currently threatened by climate change, forest degradation, inefficient land management practices and pollution. Population growth in the vicinity of the river is putting increasing pressure on the water supply. Meanwhile, growing demand for water has led to increasing conflict between water users upstream and their counterparts downstream. The abstraction of water and the siltation of dams upstream have reduced the river's ability to generate power. The reduced water flow has also led to increasing environmental degradation, with the water shortage disrupting ecological processes and sustainable livelihood practices. The multiple uses of the Pangani River and insufficient funds for proper water resources management threaten efforts to conserve the natural resource, and the diversity of users and their relationships with the environment have posed additional challenges to management plans.

cont'd p. 23

Box 8 (cont'd)

THE PANGANI RIVER BASIN MANAGEMENT PROJECT

The Pangani River Basin Management Project aims to undertake three key actions: 1) assess environmental flow requirements to effectively conserve the basin's natural resources, 2) establish forums for community participation

in water management, and 3) raise awareness about climate change impacts and adaptation strategies.

Authorities have made efforts to understand current and future climatic vulnerability by developing and using information for equitable water allocation in a changing hydrological regime. The project has also worked to negotiate outcomes that minimize future climatic vulnerability and risk through continuing dialogues with sustainable water resources management, and mainstreaming climate change adaptation in the water sector via national linkages and past management experiences. Moreover, management of the Pangani Basin is now expanding beyond the scope of water management and regulation.The recent formation of the Water Resources Management Program, National Rural Water Supply and Sanitation Program, and Urban Supply and Sewerage Programme are among the moves made to approach water basin management on a more holistic level.

LATEST OUTCOMES

While the Pangani River Basin Management Project is still under implementation, there have already been a number of notable achievements:

- Poverty reduction measures traditionally call for increasing agricultural output, but water allocation in the Pangani already favours the agricultural sector, limiting any moves to further prioritize the sector. The redirection of water to the downstream site of the Pangani hydropower station—a more degraded environment—has led to an outcome that is more environmentally beneficial.
- The Kikuletwa Catchment Forum is working to decentralize water management. Earlier water forums gave water users the opportunity to discuss and analyze local water management issues, and to have a say in the allocation of water and negotiate equitable solutions to water conflicts. The Kikuletwa Catchment Forum, however, will benefit from instructions and guidance regarding its composition, mandate and management responsibilities.
- The Pangani Basin will be especially hard-hit by climate change. It is predicted that the glacial ice cap on Mount Kilimanjaro will melt completely by 2025. A 1.8–3.6°C temperature increase, decreasing rainfall and increased evaporation in the basin are expected to result in a 6–10% decrease in annual service flows in the basin.The Pangani River Basin is working to address climate change preparedness and adaptation among water managers and water users in the environmentally sensitive and vulnerable Pangani Basin.

Current management efforts in the Pangani Basin illustrate the importance of community participation and awareness-raising in finding acceptable resolution to water conflicts. The management project also demonstrates the need to anticipate and incorporate the needs and impacts of various actors on the state of the water basin. Moreover, the flow assessment conducted in the area illustrated that management of the water basin requires a multi-sectoral approach given the linkages within the ecosystem.

Job de Graaf/Flickr.com

Pangani River in flood near Korogwe

Source: Pangani River Basin Management Project, http://www.panganibasin.com/project/index.html

BOX 9: Guatemala—Mexico Tacaná Watershed Project

The Tacaná Watershed project in Guatemala and Mexico illustrated how the decentralization of watershed management and the integration of policy can result in a more optimal outcome for all stakeholders.

THE SITUATION

The Tacaná Watershed project covers an area of 3,170 km^2 on the border zone between the department of San Marcos, Guatemala, and the state of Chiapas, Mexico. The region lies between the watersheds of the Suchiate River, forming most of the frontier between the two countries, and the Coatán River, which arises in Guatemala and then flows into Mexican territory.

In 2003, the IUCN began a restoration project to repair the heavily degraded watershed. The main goal of the project was to reverse environmental degradation and especially the degradation of the watersheds, which are of great strategic importance for both Mexico and Guatemala since they supply water to a large number of residents in the cities located in the lower areas and are the main sources of irrigation for agricultural and livestock purposes. The risk of devastating floods is also significantly reduced by restoring the watersheds.

The upper watershed of the Tacaná basin is home to a number of coffee plantations, which have led to erosion and increased the risk of flooding and mudslides. The sugar cane and coffee industries have also increased pollution in the middle basin. Further downstream, communities and industries are often affected by water scarcity in the dry season. Deforestation, agriculture and pollution are not the only threats to the Tacaná basin, however, as dispersed authority, sectoral approaches, inadequate laws and regulations, budgetary constraints, the absence of integrated policies, and the lack of participation and transparency have all impacted the quality and availability of water in the basin.

THE PROJECT

IUCN–Mesoamerica worked with various partners to implement an integrated management approach in the Tacaná Watershed. This four-year project had four main objectives: 1) consolidate mechanisms for the coordination and management of water resources with an integrated approach, 2) gather information for creating sub-basin management plans, 3) implement a strategy for raising awareness and information- sharing, and 4) build strategic alliances for the implementation of sub-basin management plans in the short, medium and long term. The IUCN worked directly with local organizations and initiated alliances between local groups through numerous pilot projects which created knowledge-sharing networks. Local communities were informed of the consequences of unsustainable environmental management and were involved in identifying different demands and priorities on water use and watershed management.

Francisco Visoni, Tacaná Project

Reforestation in the community of Toninchincalaj, Tacaná

The Tacaná Watershed Project initiated seven micro-watershed councils in Guatemala that helped to strengthen water governance in a country where water management regulations were virtually non-existent. Municipalities in Mexico and Guatemala also collaborated in the project by integrating their micro-basin management policies. An agreement between the two countries, the Tapachula Declaration, was signed to develop joint projects on watershed management.

The Tacaná project also led to the creation of the Coatan River Watershed Committee in Chiapas, Mexico. A voluntary association was formed and led to the construction of 19 greenhouses that received certification from the Exporters Association of Guatemala for growing flowers and plants.

THE OUTCOME

The Tacaná project raised local awareness of the importance of sustainable watershed management. Local communities have worked to diversify farming systems through methods such as the terracing of degraded slopes. Efforts to reduce watershed pollution have led to reforestation and the introduction of agroforestry. Communities are also investing their labour and capital in the restoration of natural infrastructure and are working to better adapt themselves to the consequences of climate change and severe storms.

The Tacaná project illustrates the need for decentralized, muli-sectoral management of water basins. The project recognized the links between agriculture, deforestation, and the quality and availability of water. The project also demonstrated that large-scale sustainable management projects can be made possible through integrating and synchronizing local initiatives. Moreover, this IUCN project demonstrated that sustainable watershed management can reap economic benefits by decreasing local vulnerability to floods and storms, and ensuring the future productivity of local agriculture plots.

Source: IUCN: Guatemala-Mexico Tacana Project, 2009, http://cmsdata.iucn.org/downloads/guatemala_mexico_tacana_project.pdf

Vladimir Dobretic

Obedska Bara Special Nature Reserve, Serbia

BOX 10: Protecting Biodiversity in the Sava Basin Floodplains

The Sava River is the second-largest tributary to the Danube River. The river originates in Slovenia and runs for 950 km through Croatia, Bosnia and Herzegovina, and Serbia. The Sava is a unique example of a river where the floodplains have remained intact and continue to support biodiversity and mitigate floods. The Sava River also hosts the largest alluvial floodplain wetlands site in the Danube basin as well as the largest lowland forests. Lack of environmental infrastructure and institutional mechanisms for addressing transboundary impacts is causing serious environmental concerns in the basin.

THE PROJECT

In 2007, the International Union for Conservation of Nature (IUCN) and Wageningen International (WI) initiated the Protection of Biodiversity of the Sava River Basin Floodplains project to support the Sava Basin countries in protecting and managing biological and landscape diversity along the Sava River. The project aimed to establish transborder cooperation and agreement between the Sava countries to designate and manage an ecological network of protected areas. Italso promoted sustainable land use practices, rural tourism, and integrated management of the Sava River Basin.

The project was coordinated by a project management team formed by IUCN and WI. A project steering committee (PSC), a technical coordination group (TCG) and four working groups (WGs) were also formed to support the project's activities. The PSC consisted mainly of ministerial representatives from Sava Basin countries and oversaw the work of the WGs, which was directed by the TCG. The WGs' work primarily focused on biodiversity, land use, Geographic Information Systems, and awareness-raising.

THE OUTCOME

The project closed at the end of December 2009. Outcomes include: a list of important sites for biodiversity; field formats and guidelines for site, habitat and species mapping; a GEO portal, which also served as a communication platform for the project; three issues of a newsletter published in English and the native languages of the Sava countries; an awareness-raising strategy elaborated and implemented; an initial agreement for future collaboration between the various stakeholders signed with the International Sava River Basin Commission (ISRBC); and a letter of intent signed by the Sava countries to designate and manage an ecological network of protected areas, ecological corridors, buffer zones and restoration areas in accordance with the EU Birds & Habitats Directives and Water Framework Directive, to increase cooperation between the nature protection sector and the water management sector on management within and among countries.

The project achieved its goal of improving transboundary cooperation on the protection and management of the landscape and biodiversity along the Sava River. It illustrates how extensive transboundary cooperation is necessary for the successful integrated management of water resources, as political and legislative challenges can hinder the development of the holistic water management plans outlined under IWRM.

Source: Protection of Biodiversity of the Sava River Basin Floodplains – Project Document, http://www.savariver.com/index.php

Victor Rodas, Tacaná Project

Coastal marine ecosystem, Los Faros, Suchiate River Basin, community of Ocos, Guatemala

The linkages between forests and wetlands illustrate the value and imperative to adopt the multi-sectoral framework outlined in the ecosystem approach. Sustainable forest management and the ecosystem approach are similar and compatible models. Many of the guidance policies of SFM fit under the ecosystem approach framework (Box 11). The key difference between the two management systems is scope. The ecosystem approach recognizes that sustainable management of a protected area may require the conservation of areas and the implication of stakeholders outside the designated zone. Current sustainable forest management policies may be enhanced by expanding upon its programme of work into areas that indirectly affect the state and function of protected zones. Conversely, watershed management policies may also wish to consider the value of conserving surrounding forests.

The Ecosystem Approach (EA)

The Convention on Biological Diversity defines the ecosystem approach as:

> *A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompasses the essential structures, processes, functions and interactions among organisms and their environment. It recognizes that humans with their cultural diversity, are an integral component of many ecosystems.*[29]

The ecosystem is seen as a dynamic web of plant, animal, and micro-organism communities and their non-living environment interacting as a unit. The scale of an ecosystem can vary from a grain of soil to the entire biosphere and is dependent upon the nature of the management and conservation processes being undertaken.

In implementing management practices, the EA calls for a focus on the structure, processes, functions, and interactions among organisms and their environment. This includes humans and their cultural

30 COP 5 decision V/6

BOX 11: Nepal – Community-led initiative to mitigate water-induced disasters

The Madhumalla community in southeastern Nepal offers a compelling example of how a grassroots bioengineering initiative not only helped to reduce the threat of flooding in the local area, but also provided additional ecosystem goods and services.

THE SITUATION

The Himalaya range, home to some 1.3 billion people, is among the richest freshwater bodies on Earth. The area's rugged yet dynamic mountain system is highly prone to mass-wasting while seasonal monsoon precipitation often brings extreme natural events which threaten the ever-increasing population in an already densely populated region. Located along the central belt of the Himalaya range, Nepal has been subject to the risks associated with mass-wasting and flooding each year. The floods not only threaten the lives and livelihoods of its population, but they also account for more than half of disaster-related deaths in the country. In recent decades, climate change has increased the frequency and intensity of torrential rains and other extreme climate events.

The community of Madhumalla in the Morang district in southeastern Nepal is located on the right bank of Mawa River—a small rain-fed river with an upper watershed of just about 20 km^2. This 25 km long river has an average gradient of 4% in the upper reaches and 2% in the lower reaches, and a width varying between 200 and 700 m. Like most rivers originating in the southern belt of Nepal, Mawa River faces unpredictable flooding mainly caused by monsoon rain. Sudden cloud-bursts in the upper watershed often generate torrents laden with debris, boulders and sediments. The process brings about rapid changes in river morphology with a cycle of aggradation and degradation of river bed, undercutting, erosion and overflowing of river banks, and shifting of the entire river course. Consequently, the population living in the vicinity is under a constant threat of severe flood damage to their homes, crops and community.

THE PROJECT

In the mid-1990s, the Madhumalla community, then led by Chairman Kashi Nath Paudyal, embarked on a mission to address the threats posed by the unpredictable and devastating floods that had occurred in the area.

The community began planting a series of stratified green belts along the river consisting of some 6,500 varieties of native trees, shrubs and grasses. Reinforcing materials were installed to prevent the undercutting and erosion of the banks and the degradation of the flood plains. Structural additions such as embankments and spurs made of gabion boxes were placed at selected locations as an additional protection measure for the green belt.

The project was designed and implemented on the basis of the community's indigenous knowledge. This included experiences regarding the characteristics of locally available plant varieties vis-à-vis their relative strengths to withstand forces of river water, as well as an understanding of the local physical environment and the river morphology. Much of the funding was also mobilized locally in the form of cash, labour, and material assistance. National and international donors also contributed US$ 40,000 in grants.

THE RESULTS

The project was a huge success and has been replicated in several other communities in the region. Not only have the plantings been able to effectively mitigate the threat of flooding, but the plantings are also producing income from the sale of forest products. It is expected that in a few years, the project will generate hundreds of thousands of US dollars annually for the local community. Currently, the project area is serving as a training centre for bioengineering technology.

The Madhumalla project illustrates how a community initiative tailored to local needs has been able to turn a potential danger into a mechanism for generating revenue.

Wildxplorer/Flickr.com

The Himalayas

Source: Shrestha and Ganai (2009). "Nepal: a community-led initiative to mitigating water-induced disasters", p. 282 in World Water Assessment Programme. 2009. The United Nations World Water Development Report 3: Water in a Changing World. *Paris: UNESCO, and London: Earthscan.http://www.unesco.org/water/wwap/wwdr/wwdr3/.*

diversity. EA also emphasizes the need for adaptive management and enhanced benefit-sharing to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Moreover, EA recognizes that there is no single way to implement the approach since it depends on local, provincial, national, regional, and global conditions. Other management and conservation approaches may be integrated into the EA framework.

AT THE CORE OF THE ECOSYSTEM APPROACH ARE 12 GUIDING PRINCIPLES:

1. Management of land, water, and living resources are a matter of societal choice.
2. Management should be decentralized to the lowest appropriate level.
3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
4. There is a need to understand and manage the ecosystem in an economic context. Therefore, an ecosystem management programme should:
   - Reduce market distortions that adversely affect biological diversity
   - Align incentives to promote biodiversity conservation and sustainable use
   - Internalize costs and benefits in the given ecosystem to the extent feasible
5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
6. Ecosystems must be managed within the limits of their functioning.
7. EA should be undertaken at the appropriate spatial and temporal scales.
8. Objectives for ecosystem management should be set for the long term due to the varying temporal scales and lag-effects that characterize ecosystem processes.
9. Management must recognize that change is inevitable.
10. EA should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
11. EA should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
12. EA should involve all relevant sectors of society and scientific disciplines.

In applying the 12 principles, the ecosystem approach focuses on the functional relationships and processes within ecosystems with recognition that such processes and functions are complex and variable. EA seeks to enhance benefit-sharing, carry out management actions at the appropriate scale and decentralized to the lowest level, and to ensure inter-sectoral cooperation.

Sustainable Forest Management

Sustainable forest management (SFM) is the most common forest management conservation practice under implementation. The most widely intergovernmentally agreed-upon language for SFM adopted by the United Nations General Assembly is given below.

> *Sustainable forest management as a dynamic and evolving concept aims to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations. (Resolution 62/98, December 2007)*

At the core of SFM lie the Forest Principles, which were adopted at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. The Forest Principles aim to manage forest resources and forest lands in order to meet the social, economic, ecological, cultural, and spiritual needs of present and future generations. These needs include forest products and services such

as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, and carbon sinks and reservoirs, among others.[31]

Nine different sets of criteria and indicators for sustainable forest management have been adopted by 150 nations around the world. Seven common themes have emerged as the theoretical basis for developing forest management practices worldwide:

- Extent of forest resources
- Biological diversity
- Forest health and vitality
- Protective functions of forests
- Productive functions of forests
- Socio-economic functions
- Legal, policy and institutional framework

In practice, SFM has resulted in the development of national forest programmes, landscape restoration, integrated mountain development, and integrated, participatory watershed management, among others.

In addition to the globally agreed definition, a number of multilateral, regional and national definitions exist, as well as criteria and indicator processes, which aim at operationalizing the concept of SFM. For example, the "Forest Europe" process has adopted an ambitious definition (Resolution H1, 1993) with detailed criteria and indicators for SFM.[32]

Integrated Water Resource Management

Integrated water resource management (IWRM) is increasingly being recognized as the most effective and holistic means of managing our water resources. The crucial role of water in human survival and economic development was officially recognized at the 1972 UN Conference on the Human Environment. It was not until the UN Earth Summit in 1992, however, that water was officially recognized as a finite and vulnerable resource. The Earth Summit also pioneered the concept of a holistic approach to water management.

Since 1992, water has been seen less as a commodity and more as a resource that needs to be equitably distributed among all users, including nature[33]. At the World Summit on Sustainable Development held in Johannesburg in 2002, the international community—under Article 26 of the WSSD Plan of Implementation—called for the development and implementation of IWRM by 2005.

> *IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.*[32]

31 Wilkie M. et al. "Sustainable Forest Management and the Ecosystem Approach: Two Concepts, One Goal" *Forest Management Working Papers, Working paper FM 25.* FAO, Rome 2003 p. 2, 10-14

32 FOREST EUROPE Helsinki Resolution 1 General Guidelines for the Sustainable Management of Forests in Europe: http://www.mcpfe.org/filestore/mcpfe/Conferences/Helsinki/helsinki_resolution_h1.pdf

33 UNEP. *Water Security and Ecosystem Services: The Critical Connection*. Nairobi 2009 p.13-14

34 Global Water Partnership. 2000. *Integrated Water Resource Management*, Technical Advisory Committee Background Papers No. 4, Stockholm: Global Water Partnership Technical Advisory Committee, p. 22.

IWRM recognizes that we all live in and with the hydrological cycle: water constantly moves over or under the ground, evaporates into the atmosphere and then recycles as rain or snow. As it passes through the ground, we use it in many ways, and need to share it in a way that does not destroy the ecosystems that provide it.


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IWRM recognizes that all institutions and groups of people with an interest in water need to work together to identify the full suite of benefits and costs of various kinds of water use to find an appropriate balance between resource protection and development. This balance could vary among different water bodies.

Modern IWRM is based on the four *Dublin Principles* (below), which were agreed upon at the International Conference on Water and the Environment in 1992. These principles reflect the idea that development, if it is to be sustainable into the future, must address three fundamental issues: environmental integrity, economic development, and social justice.

- Fresh water is a finite and vulnerable resource, essential to sustain life, development, and the environment.
- Water development and management should be based on a participatory approach involving users, planners, and policy-makers at al levels.
- Women play a central part in the provision, management, and safeguarding of water.
- Water has an economic value in all its competing uses and should be recognized as an economic good.

IWRM also recognizes that healthy river flows must be viewed as a crucial element of sustainable water management initiatives. Measuring environmental flows allows scientists to develop optimal water management plans. By determining and ensuring minimum water flows and regulating the timing of the flows, water management authorities are able to better maintain rivers and the aquatic systems, as well as the ecological services they provide.

Framing issues within holistic approaches

While the EA, SFM and IWRM are all holistic approaches that share a number of common goals, the framing differences between these approaches may have an impact on their implementation. SFM, for example, originated in the forest sector and may therefore inadvertently overlook some crucial linkages that forests have to wetland biodiversity and to water. IWRM, however, places a special focus on water systems, and may consequently neglect the vital interplay between forests and those systems. While ecosystem management plans may be formed to meet a certain need or address a specific issue, it is important to view all management schemes from an ecosystem perspective to ensure that crucial linkages are not overlooked. This will help ensure the best possible solution to the task at hand, while simultaneously maintaining the integrity of linked ecosystems.

POLICY OVERVIEW: CONVENTION ON BIOLOGICAL DIVERSITY

There are many policy aspects relevant to the overlap between water, wetlands and forests in the Convention on Biological Diversity (CBD) as a result of the cross-cutting nature of biological diversity as a whole, as well as the inherent ecosystem linkages between the various programmes of work. Many policy linkages are implied in CBD decisions VI/22 and IX/5 on forest biological diversity, decisions IV/4 and IX/19 on inland water ecosystems, and decision V/6 on the ecosystem approach (see appendix). However, there is a need for further coherence and clarity between these decisions and to the resolutions and guidance provided by the Ramsar Convention in relation to water, wetlands and forests.

There are other important linkages between forests and wetlands other than through surface water inter-dependencies. For example, carbon storage is an important link between the CBD and the Ramsar Convention in relation to forests; for instance, peatlands (a type of wetland) store over twice the carbon of all the world's forests, and many of these, in particular in tropical areas, are forested. Also, as a general rule "wet" (humid) forests store more carbon than dry forests. Terrestrial forests, even in dry areas, can have further links to wetlands through their dependency on groundwater because wetlands can play a critical role in the regulation of groundwater supplies, often across large distances between wetlands and forested areas. Likewise, artificial forests, in particular plantations using water-demanding tree species, can exert an influence on groundwater availability and therefore affect surface water availability for wetlands.

There are also many implicit policy linkages between water, wetlands and forests in the CBD as a result of the ecosystem linkages and the implications that guidance over one aspect would necessarily have on another. In the expanded programme of work on forests, for example, the CBD calls for a "comprehensive set of goals, objectives, and activities required for the conservation of forest biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from the utilization of forest genetic resources." When outlining these goals, it is imperative that the interactions and interdependence between forests and wetlands be properly accounted for to ensure that efforts for conservation and sustainable use carry the scope necessary to ensure effectiveness.

The programme of work on forests goes on to state that "Parties should implement the expanded programme of work on forest biological diversity in the context of their national priorities and needs." The ecological and economic linkages explained earlier make it clear that any work on forests must also encompass the interactions between forests, wetlands, and water when determining national priorities and needs. Furthermore, the importance and scarcity of fresh water makes this resource and the related ecosystems a top priority for all nations.

The expanded programme of work on forests also promotes "integrated approaches to reduce negative impacts and enhance positive impacts of other sectoral policies on forest biological diversity with a view to developing a tool kit for building capacity in integrated approaches and planning." Such integration must view ecosystems in their entirety (including the water, wetland, and forest interaction), and therefore any tool kit for building capacity within the realm of forests must account for this interaction to prevent forest management strategies that may have negative externalities on water resources or wetlands. Such linkages and implications should also be more explicitly factored into the assessment of unauthorized harvesting of forest biodiversity and its impacts on fauna and flora, indigenous and local communities, and revenue loss—since an assessment based solely within the forested area would not properly account for the direct implications on water resources and wetlands. These linkages must also be accounted for in the economic valuation of forest biodiversity goods and services.

The CBD's expanded programme of work on forest biodiversity also urges Parties to recognize "the vital role that women in indigenous and local communities play in the sustainable use and conservation of forest biological diversity, especially but not limited to the sustainable use and conservation of non-timber resources, and values." This also directly relates to the increased burden that women have in collecting water and the Millennium Development Goal to promote gender equality and empower women. It is therefore necessary to recognize the vital role that women have in both aspects of these linked ecosystems and the services that they provide, and the compounded effect that mismanagement of the link between these ecosystems has on women in particular.

The expanded programme of work also "encourages Parties and other Governments to develop closer collaboration for the conservation and sustainable use of transboundary forest ecosystems," which should also encompass linked water systems and wetlands to ensure proper management.

In a similar fashion, there are also several notable overlaps between forests and wetlands that can be found in CBD decisions regarding inland water ecosystems and options for conservation and sustainable use (decision IV/4). The decision urges parties to give priority to "preparing and implementing integrated watershed, catchment, and river basin management plans based on an ecosystem approach," which necessitates that proper consideration be given to the surrounding forests involved in the ecosystem. The work plan for inland waters also calls for developing an "improved picture of inland water biological diversity, its uses and its threats, around the world," which must include the surrounding forests that help to provide for the flourishing biological diversity in these ecosystems.

Taking into account human interaction and utilization of these ecosystems, the work plan mentions the importance of studying watershed, catchment, and river basin management experiences and best practices, along with water resource development projects, irrigation, hydropower, and flood control programs that incorporate biological diversity considerations. Once again, these studies would be moot without due consideration to the forests that play an integral role in these ecosystems. The Conference of the Parties recommends that Parties adopt an "integrated land and watershed management approach" to ensure that these interactions are not overlooked—specifically noting that wetlands can be used to improve water quality and that forests and wetlands can be used to recharge groundwater, maintain the hydrological cycle, protect water supplies, and prevent flood damage. Forestry is also listed among activities which require environmental impact assessments due to its impact on inland waters and water resources as a whole.

All of the implied policy linkages above result from the application of the ecosystem approach. This implores Parties to account for the ecosystem linkages when prescribing policy (in this case, the impacts of forest management policies on inland waters, and vice versa). The CBD defines the ecosystem approach as "a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way [… and therefore] requires adaptive management to deal with the complex and dynamic nature of ecosystems." The ecosystem approach, therefore, requires Parties to account for the ecosystem linkages described herein and ensure that policies promote their conservation and sustainable use without neglecting the externalities that policy measures in one area may have on another as a result of these linkages.Within the recommendations to Parties in COP decision IV/4, it is explicitly stated that "inland waters provide both a challenge and an opportunity to educate the public and policy makers about the need to take an ecosystem-based approach to management," thereby reinforcing the links that inland waters have to other systems, such as forests, and imploring the Parties to take these linkages into consideration when determining management policies and best practices.

Amy Pregger/Flickr.com

Mangroves

POLICY OVERVIEW: RAMSAR CONVENTION ON WETLANDS

While Ramsar focuses primarily on wetlands, the ecosystem linkages between wetlands and forests create the need to consider forests in wetland policy and visa versa. Article 2 of the Ramsar Convention mentions that hydrology should be considered among the criteria for inclusion on the List of Wetlands of International Importance, thereby implicating linkages between wetlands and the surrounding forests. Article 3 calls for Parties to implement their planning "so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory." Once again, proper use and conservation of wetlands must also encompass the surrounding forested areas, given their interdependence and the impacts that management of one area may have on the other.

Ramsar's mission is "the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world." In its first "Wise Use" handbook[35], Ramsar gives its definition of wise use of wetlands: "Wise use of wetlands is the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development." By advocating this approach, Ramsar therefore necessitates that all Parties use the ecosystem approach when managing wetlands to account for the linkages and interdependence between wetlands and forests.

This policy integration of wetlands, water, and forests is evident in many of Ramsar's Wise Use handbooks. Handbook 2, for example, mentions that "wetlands have been identified as one of the key life support systems on this planet in concert with agricultural lands and forests," and uses this rationale to advocate coordinated government programmes to minimize the adverse effects that policies created for a related sector may inadvertently have on wetlands. It is with this in mind that Ramsar advocates the

35 Ramsar Convention Secretariat. 2007. *Ramsar Handbooks for the Wise Use of Wetlands, third edition*. Ramsar Convention Secretariat, Gland, Switzerland.

development of "a unique or 'stand alone' wetland policy statement and/or strategy," but it is important that such strategies are carefully integrated with interrelated sectors such as agriculture and forestry.

Handbook 3 focuses on cross-sectoral policies and warns Parties that "wetlands are directly or indirectly affected by a large number of sectoral activities, ranging, *inter alia,* from marine transportation and port and harbour construction through fisheries and forestry to domestic and foreign trade and investment." It then goes on to point out the collateral damage that often befalls wetlands as a result of the policy gaps caused by sector-specific legislation that has no mandate for wetland conservation or wise use. To correct this gap, Ramsar states the need for integration of regulations and guidelines regarding land uses on river systems and associated wetlands (Handbook 7). An example of damage caused by neglecting this gap is highlighted by the case of mangroves, which are often administered by forestry authorities without cross-sectoral coordination—thereby overlooking their important functions in coastal flood protection and the provision of fish spawning and nursery areas, resulting in major market failures with economically disastrous consequences.

Ramsar takes the economic considerations surrounding water, wetlands and forest interactions into consideration by stating that it must engage with business sectors to ensure that activities undertaken are not acting contrary to the objectives of the Convention (Handbook 4). The recommendations go on to encourage the application of Ramsar wise use practices through professional associations to promote these practices within key business sectors (such as water and sanitation, irrigation and water supply, agriculture, mining, forestry, fishing, environmental managers, tourism, waste disposal, and energy).

The remaining Wise Use handbooks account for the important water, wetland and forest relationship by advocating the need to incorporate appropriate management of terrestrial ecosystems into water resource management (Handbook 8); the importance of recognizing the intricacies of upstream-downstream relations and the specific impact of deforestation on those relations (Handbook 10); and the need for "integrated river basin management" (IRBM) as a holistic approach integrating wetland conservation and wise use into river basin management (Handbook 16).

THE RAMSAR CONVENTION ON WETLANDS AND ITS COVERAGE OF FORESTED ECOSYSTEMS

The Ramsar Convention covers a broad range of wetlands, from the mountains to the sea, including inland, coastal and human-made wetlands. Its coverage includes both non-forested and forested wetlands. In the Ramsar classification of wetland types, developed to support the designation of Wetlands of International Importance (Ramsar sites), three types of forested wetland are recognized:

> **Intertidal forested wetlands**: including mangrove swamps, *nipah* swamps and tidal freshwater swamp forests [type I];
>
> **Freshwater, tree-dominated wetlands**: including freshwater swamp forests, seasonally flooded forests, and wooded swamps on inorganic soils [type Xf]; and
>
> **Forested peatlands**: including peatswamp forests [type Xp].

Many designated Ramsar sites worldwide include such different types of forested wetlands, and so the Ramsar sites network provides a major contribution to the implementation of CBD's programmes of work on both forest ecosystems and protected areas. Of 1,886 Ramsar sites (covering 185,156,612 ha) (as of 10 February 2010), 202 sites (covering 22,406,398 ha – 12% of the total area) in 74 countries in all regions of the world are predominantly one or other of these three types of forested wetlands. Countries with the largest number of such forested wetland Ramsar sites are: Mexico (18), Finland

(14), Sweden (10), Australia (9) and the USA (7). Nine countries have designated over 500,000 ha of predominantly forested Ramsar sites, the largest areas being in Brazil: 3,804,911 ha (2 sites); Bolivia: 1,472,636 ha (2 sites) ; USA: 893,225 ha (7 sites); Cuba: 714,411 ha (4 sites); Mozambique: 688,000 ha (1 site); Bangladesh: 601,700 ha (1 site); Indonesia: 576,510 ha (2 sites); Australia: 523,686 ha (9 sites); and Guatemala: 526,367 ha (4 sites). Thirteen other countries have designated over 100,000 ha of such wetlands: Congo, Costa Rica, Cote d'Ivoire, Estonia, Finland, France, Gabon, Guinea, Malaysia, Mexico, Paraguay, Sweden and Thailand. A total of 665 Ramsar sites, with a total area of 79,273,475 hectares—43% of the total Ramsar site area—have forested wetlands within their boundaries.

By dominant forested wetland type, there are 87 intertidal forested wetlands (largely mangrove systems) covering 8,851,696 ha; 82 *freshwater, tree-dominated wetlands* covering 12,880,462 ha, and 50 Forested peatlands covering 1,038,910 ha. Whilst intertidal forested wetlands and freshwater, tree-dominated wetlands are widely distributed geographically, most forested peatland Ramsar sites are boreal systems, mainly in Europe (especially Estonia, Finland and Sweden). Only three such Ramsar sites are predominantly tropical forested peatlands: Berbak (Indonesia – 162,700 ha); Tasek Bera (Malaysia - 38,446 ha), and Pru To Daeng Wildlife Sanctuary (Thailand – 20,100 ha).

In addition, a number of other Ramsar sites include other (non-wetland) forested areas, in recognition of the importance of the links between forests and wetlands in catchments and water management issues. Some examples of major areas of forest designated as part of Ramsar sites are:

Parc National Pongara (Gabon – 92,969 ha): Located east of the Congo Basin forest, on the southern shores of the Gabon estuary, the site includes a wide range of mangroves and forest types (riverine, swampy, littoral and flooded), grassy savannas and several rivers;

Palmar de las Islas y las Salinas de San José (Bolivia–856,754 ha): A very large area of largely pristine saline and non-saline palm *Copernicia alba* forests and the only wetlands in a large area of dry forest;

Berbak (Indonesia–162,700 ha): A vast area of undisturbed peat swamp forest and freshwater swamp forest dissected by a large river and inhabited by a small group of native people;

The Sundarbans Reserved Forest (Bangladesh–607,100 ha): At the confluence of the Ganges, Brahmaputra and Meghna rivers, whose innumerable small channels and creeks flowing into the Bay of Bengal dissect the whole area, this is the largest contiguous mangrove forest in the world;

Okefenokee National Wildlife Refuge (USA–162,635 ha): The second-largest wetland complex in the USA, and an extensive drainage basin on the divide between the Atlantic Ocean and Gulf of Mexico, characterized by swamp forest.

Cobourg Peninsula (Australia–220,700 ha). A peninsula with extensive tidal flats, estuaries, mangroves, riverine wetlands and Melaleuca (paperbark) swamps, dominated by eucalyptus forest.

Riisitunturi National Park (Finland–12,461 ha). Steep and diverse blanket "mires" (peatland on which peat is currently forming and accumulating) representing the sloping mire type; most of the Park is covered by spruce forests with nearly a hundred small ponds.

COMPLEMENTARITY BETWEEN THE CONVENTION ON BIOLOGICAL DIVERSITY AND THE RAMSAR CONVENTION

The Convention on Biological Diversity and the Ramsar Convention are linked not only as a result of the ecological linkages between the ecosystems that they work with, but also due to policy linkages between them. Ramsar incorporates the CBD directly in its mission since the wise use of wetlands requires use of the ecosystem approach as defined by the Convention on Biological Diversity. While Ramsar and the CBD have different focal points and Parties, proper implementation of either convention requires the consideration of ecosystem linkages, thereby strengthening the importance of close partnership between the CBD and Ramsar.

The primary linkage between the CBD programme of work on forests and the Ramsar Convention is water. The congruent guiding principles of each convention (with the CBD's "ecosystem approach" and Ramsar's concept of "wise use") facilitate policies to deal with the ecological linkages between water, wetlands and forests at the landscape scale. However, in practice, and at the level of the CBD's programmes of work, the relevant linkages are not always well incorporated. The CBD's expanded programme of work on forests mentions the importance of collaboration on specific issues, and it is therefore necessary to better incorporate Ramsar within the framework of forest management to address its important linkages to wetlands. The programme of work also advocates full involvement of relevant stakeholders in the implementation of the programme of work, which should again include Ramsar. The programme of work also recognizes that, in addition to the ecosystem linkages, a significant proportion of forests are, in fact, wetlands, and therefore directly fall within the scope of both Ramsar and the CBD's programmes on both forests and inland waters.

To address their common interests , the two conventions have agreed to a joint work plan, the most recent of which covers 2007 to 2010. This joint work plan is based on the Ramsar Convention being the lead partner for wetlands in implementing the CBD, and highlights the mutually supportive manner of the objectives and principles of the two conventions.

GAPS BETWEEN THE CONVENTION ON BIOLOGICAL DIVERSITY AND THE RAMSAR CONVENTION

Despite the current joint plan of work between the CBD and Ramsar, there are still needs to enhance linkages between both conventions. The CBD's programmes of work can often be restrictive when not viewed and implemented in an ecosystem/landscape context. The context of water, in this case in relation to wetlands and forests, is a good example of how artificially imposed barriers between programmes of work can be counter-productive. The Ramsar Convention guidance, for example on the wise use of forested wetlands, could be further integrated into discussions and practices of sustainable forest management in the CBD to better account for the inter-relationships between forests and wetlands. Likewise, forests could be better accounted for more explicitly in Ramsar's tools to measure the achievement of CBD targets by elaborating and using forest-related indicators in addition to wetlands and water. .

The CBD's Conference of the Parties requested the Executive Secretary to develop a roster of experts on the conservation and sustainable use of biological diversity of inland waters, and it was noted that the Ramsar Secretariat is establishing a similar list of experts. It is crucial that the linkages between water, wetlands and forests are recognized by ensuring that the list compiled is a cross-sectoral one that also includes experts on forests and water resources as a result of the crucial role that they have in relation to inland waters.

It is essential that both conventions and their respective Parties fully understand the ecosystem linkages between water, wetlands and forests to promote increased cooperation and synergies between the two conventions and to dismantle "programme of work" and/or "wetland" approaches that hamper more harmonious cross-cutting approaches that capitalize on the objectives, policies and guidance offered by both conventions. Recognizing the congruency of the "ecosystem approach" and "wise use of wetlands" is an important step.

David Coates

Khone Falls on the Mekong River in southern Laos. At this point, the river is about 12 km wide, interspersed with forest, wetlands and some 4000 islands.

APPENDIX

SUMMARY OF KEY DECISIONS ON FOREST AND WATER MANAGEMENT

CBD decisions regarding forests and inland waters can be found, respectively, at: https://www.cbd.int/forest/decisions.shtml and https://www.cbd.int/waters/decisions.shtml.

Text of the Ramsar Convention and their wise use handbooks can be found, respectively, at: http://ramsar.org/index_very_key_docs.htm and http://ramsar.org/lib/lib_handbooks2006_e.htm

The Joint Work Plan can be found at http://www.ramsar.org/cbd/key_cbd_jwp3_e.htm.

CBD DECISION IV/4

CBD decision IV/4 explains the status and trends of the biological diversity of inland water ecosystems and explores options for conservation and sustainable use to be incorporated into the programme of work.

CBD DECISION V/6

CBD decision V/6 offers an outline of the principles underlying the ecosystem approach. The decision presents the 12 key principles underscoring the theoretical rationale of the ecosystem approach and the five principle actions which ought to be undertaken to put this rationale into practice.

CBD DECISION VI/22

CBD decision VI/22 outlines the expanded programme of work on forest biodiversity. Most notably, the decision calls for increased cooperation with other environmental bodies and increased capacity-building and benefit-sharing on forest management practices.

CBD DECISION IX/5

CBD decision IX/5 advocates an expansion the CBD programme of work on forest biodiversity. The decision also recommends that parties to the convention adopt rigorous measures to protect forest biodiversity, seek opportunities to cooperate on forest management and integrate a multi-sectoral approach in forest management practices.

CBD DECISION IX/19

CBD decision IX/19 relates to the programme of work on inland waters biodiversity. It calls for increased cooperation with Ramsar and other international bodies on regional, multilateral and bilateral levels.

RAMSAR CONVENTION

The Ramsar Convention is an international treaty for the conservation and sustainable utilization of wetlands. The treaty calls for efforts to stem human encroachment and destruction of wetlands while recognizing the fundamental ecological function of wetlands and their economic, cultural, scientific and recreational values.

RAMSAR WISE USE HANDBOOKS

These handbooks bring together the various relevant guidances adopted by Parties, supplemented by additional material from COP information papers, case studies and other relevant publications so as to illustrate key aspects of the guidelines.

FOURTH JOINT WORK PLAN

The fourth joint work plan between Ramsar and the Convention on Biological Diversity is the latest memorandum of cooperation between the two bodies. This joint plan of work reaffirms the importance of ongoing cooperation between Ramsar and the CBD and outlines actions to conserve and sustain biodiversity.

Produced with the financial assistance of