RAP Publication 2005/03
Forest Perspectives 2

Forests and floods

Drowning in fiction or thriving on facts?

The Food and Agriculture Organization of the United Nations (FAO) leads international efforts to defeat hunger. Serving both developed and developing countries, FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information, helping developing countries and countries in transition modernize and improve agriculture, forestry and fisheries practices and ensure good nutrition for all. Since its founding in 1945, FAO has focused special attention on developing rural areas, home to 70 percent of the world's poor and hungry people. FAO's activities comprise four main areas: (1) Putting information within reach, (2) Sharing policy expertise, (3) Providing a meeting place for nations and (4) Bringing knowledge to the field.

The Center for International Forestry Research (CIFOR) was established in 1993 as part of the Consultative Group on International Agricultural Research (CGIAR) in response to global concerns about the social, environmental and economic consequences of forest loss and degradation. CIFOR research produces knowledge and methods needed to improve the well-being of forest-dependent people and to help tropical countries manage their forests wisely for sustained benefits. This research is done in more than two dozen countries, in partnership with numerous partners. Since it was founded, CIFOR has also played a central role in influencing global and national forestry policies.

Donors
The Center for International Forestry Research (CIFOR) receives its major funding from governments, international development organizations, private foundations and regional organizations. In 2004, CIFOR received financial support from Australia, African Wildlife Foundation (AWF), Asian Development Bank (ADB), Belgium, Brazil, Canada, Carrefour, China, CIRAD, Conservation International Foundation (CIF), European Commission, Finland, Food and Agriculture Organization of the United Nations (FAO), Ford Foundation, France, German Agency for Technical Cooperation (GTZ), German Federal Ministry for Economic Cooperation and Development (BMZ), Indonesia, International Development Research Centre (IDRC), International Fund for Agricultural Development (IFAD), Innovative Resource Management (IRM), International Tropical Timber Organization (ITTO), Italy, Japan, Korea, Netherlands, Norway, Organisation Africaine du Bois (OAB), Overseas Development Institute (ODI), Peruvian Institute for Natural Renewable Resources (INRENA), Philippines, Sweden, Swedish University of Agricultural Sciences (SLU), Switzerland, The Overbrook Foundation, The Nature Conservancy (TNC), Tropical Forest Foundation, United States, United Kingdom, United Nations Environment Programme (UNEP), Waseda University, World Bank, World Resources Institute (WRI) and World Wide Fund for Nature (WWF).

Recycled paper

RAP Publication 2005/03
Forest Perspectives 2

Forests and floods

Drowning in fiction or thriving on facts?

ISBN 979-3361-64-6

Printed by Indonesia Printer

Cover photo:
Donkey riders wade through flood waters after
a heavy monsoonal downpour in Lahore, Pakistan, 2003

Published by
Center for International Forestry Research
Food and Agriculture Organization of the United Nations

Center for International Forestry Research
Jl. CIFOR, Situ Gede, Sindang Barang
Bogor Barat 16680, Indonesia
Tel.: +62 (251) 622622; Fax: +62 (251) 622100
E-mail: cifor@cgiar.org
Web site: http://www.cifor.cgiar.org

Food and Agriculture Organization of the United Nations
Regional Office for Asia and the Pacific
Maliwan Masion, 39 Phra Atit Road
Bangkok 10200, Thailand
Tel.: + 66 (2) 697-4000; Fax: +66 (2) 697-4445
E-mail: FAO-RAP@fao.org
Web site: http://www.fao.or.th

Contents

Acknowledgements

The preparation of *Forest and floods: drowning in fiction or thriving on facts?* has been a collaborative venture. Numerous people have contributed to this booklet by sharing their experiences and thoughts, providing literature, assisting in distinguishing facts from fiction and in drafting, commenting on and editing a progression of manuscripts. FAO and CIFOR would like to thank in particular the following for participating in the process:

Moujahed Achouri, Bruce Aylward, Kenneth N. Brooks, Neil Byron, Yvonne Byron, Ian Calder, Bruce Campbell, Patrick C. Dugan, Patrick Durst, Thomas Enters, Thierry Facon, Peter F. Ffolliott, Don Gilmour, Hans M. Gregersen, Lawrence S. Hamilton, Thomas Hofer, Ulrik Ilstedt, Jack D. Ives, David Kaimowitz, Benjamin Kiersch, Philip McKenzie and Kumar Upadhaya.

Foreword

The role of forests in sustaining water supplies, in protecting the soils of important watersheds and in minimising the effects of catastrophic floods and landslides has long been discussed and debated. The International Year of Mountains (2002) and the International Year of Freshwater (2003) re-emphasised that mountainous watersheds, land use and water are inextricably linked. For decades this perceived link has served as an important justification for promoting and implementing watershed management.

Every year large-scale floods in the Asian lowlands affect the personal and economic fortunes of millions of people. To many people involved in developing disaster-reduction strategies and flood-mitigation management, it appears that the intensity of floods has increased in the region in recent decades. A common — and perhaps understandable reaction — is to blame the mismanagement of Asia's uplands and the clearing of forests in important mountainous watersheds for the misery brought to the lowlands. To a large extent, conventional wisdom — which is sometimes more fiction than fact — about the benefits of forests has clouded the perspectives of decision-makers, leading to an over-emphasis on reforestation and forest protection at the expense of more holistic watershed and river-basin management.

The conventional wisdom is that forests act as giant 'sponges', soaking up water during heavy rainfall and releasing freshwater slowly when it is most needed, during the dry months of the year. The reality is far more complex. Although forested watersheds are exceptionally stable hydrological systems, the complexity of environmental factors should cause us to refrain from overselling the virtues of forests and from relying on simple solutions (e.g., removing people currently living in mountainous watersheds, imposing logging bans, or implementing massive reforestation programmes). Rather, the complexity of these processes should prompt us to reassess our current knowledge of the relationship between forests and water, and reconsider conventional responses to one of the most serious disaster threats in the Asia-Pacific region — i.e., large-scale floods.

This booklet aims to separate fact from fiction on issues related to forests and water and to dispel some of the commonly held misconceptions about the role of forests in flood mitigation. It does not pretend to provide an exhaustive overview on the subject; rather, it aims to brief policy-makers, development agencies and the media, and so constructively contribute to the development of sound watershed and river-basin management, and flood-mitigation policies, for the region.

He Changchui
Assistant Director-General and
Regional Representative for Asia and the Pacific
FAO

A Chinese father and his daughter wade through flood waters in Jintang County, Chengdu, Sichuan Province, June 29, 2004. The low-lying county along the Yangtze River is frequently flooded by heavy rains during the summer

Introduction

Every year, reports of large-scale flooding in the Asian lowlands capture headlines and dominate newscasts. The 1980s and 1990s will be particularly remembered for catastrophic floods and their profound effects on people, property and economies in many Asian countries.

Who doesn't recall the flooding of the Yangtze River in 1998, which devastated large areas of central China and resulted in damage in excess of US$30 billion? Between January and August 2004, 46 million people were affected by floods in China. Floods in 2000 affected 3.5 million people in Cambodia (one-third of the population) and 5 million in Viet Nam, with associated costs of US$145 million and US$285 million, respectively. In the same year, floods in Bangladesh displaced more than 5 million people and in India 30 million. A single flood in 1999 in the small, central province of Thua Thien Hue, Viet Nam, led to the deaths of 400 people and damage to property worth US$120 million, or one-half of the province's annual GDP. Nearly every country in the region has suffered the effects of catastrophic floods at one time or another. Globally, floods affect the personal and economic fortunes of more than 60 million people each year.

Much has been written about floods, their causes and impacts. Debate has been intense about how to prevent, mitigate and manage them. Each tragic event inevitably becomes a political issue. Political survival demands that politicians are seen as responding to each crisis in quick fashion. Thus, officials seek immediate answers and short-term solutions. In many countries, there is widespread belief — including among many foresters — that forests can prevent or reduce floods. Therefore, an immediate, frequently drawn conclusion is that floods occur because forests have been cleared or degraded. Hence it is but a small step to presume that the continuing deforestation of Asia's watersheds is the cause of the misery brought to millions of people every year.

The reality, however, is that direct links between deforestation and floods are far from certain. Although the media attributes virtually every flood-related tragedy to human activities — particularly to agricultural expansion and timber harvesting (typically characterised by the press as 'rampant illegal logging' irrespective of legality or harvesting methods employed) — hydrological systems are so complex that it is extremely difficult to disentangle the impacts of land use from those of natural processes and phenomena.

In the case of upland/lowland as well as forest and flood relationships, existing 'knowledge' is frequently based more on perceived wisdom, or myths, than on science. In the rush to identify the culprits for the most recent disasters, assumptions are made about processes in one region based on observations from other regions which often have quite different environmental characteristics, or by extrapolating from small to large scales.

Oversimplification is common, frequently leading to initiatives such as logging bans or the resettlement of people residing in watershed areas — often with minimal environmental benefits but very definite negative social and economic implications. The unfortunate outcome is that intended results are rarely achieved, but scarce funds are misallocated and unnecessary hardships are heaped upon those segments of society that become scapegoats for flood-related disasters and damages.

All floods cannot and should not be completely prevented — flooding is important for maintaining biodiversity, fish stocks and fertility of floodplain soils. In many floodplains, certain crops (e.g., jute or deep water aman rice in Bangladesh) depend on seasonal flooding. However, steps can be taken to limit the adverse impacts of floods and to ensure effective responses to flooding events. This requires a far better understanding of the interactions between human activities and floods, the limitations of watershed management and the role of floodplain or river-basin management in reducing flood-related impacts.

As a first step, decision-making needs to be supported by an objective perspective of the relationships between forests and water, in order to distinguish myths and conventional wisdom from facts and sound science. Building on better understanding of physical processes and the relationships between land use and hydrology, more effective responses can be designed to reduce the magnitude of disasters without repeating the mistakes of the past.

Recent flood in Cambodia (courtesy of Mr Ty Sokhun, Forest Management Office, Department of Forestry and Wildlife, Cambodia through Water Resources Section, UNESCAP)

Distinguishing fact from fiction

Are floods caused by nature or by human activities? This question has been posed for decades and the issue has been researched and discussed extensively in scientific circles. Surprisingly, in many countries sound science has had relatively little impact on people's perceptions and beliefs. Partly, this is because the general public finds it difficult to distinguish between good and poor science, or between facts and plausible fiction. It may also be that some people find it more convenient or advantageous to perpetuate certain myths, rather than to address the issues in a sound, scientific framework. Hamilton (1985) has characterised this situation as 'The 4 Ms: myth, misunderstanding, misinterpretation, and misinformation.'

Although a great deal is known about hydrological processes and the relationship between forests and floods, this knowledge is often used to make generalisations that are frequently inappropriate or misleading. There is a propensity to rely on simple cause-effect relationships, when in reality natural environments are extremely complex. Such complexity and the overlapping influences of human activities on hydrological systems are frequently oversimplified, particularly by the media and public officials seeking simple explanations and solutions. Moreover, the inherent uncertainties of many scientific findings and the absence of long-term research are downplayed. Little distinction is made between what we know, what we think we know or what we want to believe, contributing substantially to the general confusion surrounding the effects of forests on major floods. Also, while the hydrological processes are well-established, the site-specific nature of the many interactions leads to uncertainty in generalisations.

Much of this confusion has a long history and relates to the so-called 'sponge theory'. Although the exact origin of the theory is unclear, it appears to have been developed by European foresters at the end of the 19th century. While it has never been confirmed, many people have found it agrees with their own professional understanding and intuition. According to the theory, the complex of forest soil, roots and litter acts as a giant sponge, soaking up water during rainy spells and releasing it evenly during dry periods, when the water is most needed. Although the theory came under criticism as early as the 1920s, it continues to appeal to many people (foresters and non-foresters alike). In many countries, it is firmly embedded in national forest policies and programmes. The question is how much of the sponge theory is fact and how much is fiction?

An early American view on forests and floods

Rain which falls over a bare slope acts differently. It is not caught by the crowns nor held by the floor, nor is its flow into the streams hindered by the timber and the fallen waste from the trees. It does not sink into the ground more than half as readily as in the forest, as experiments have shown. The result is that a great deal of water reaches the streams in a short time, which is the reason why floods occur. It is therefore true that forests tend to prevent floods. But this good influence [of forests on floods] is important only when the forest covers a large part of the drainage basin of the stream. Even then the forest may not prevent floods altogether. The forest floor, which has more to do with the fallen rain water than any other part of the forest, can affect its flow only so long as it has not taken up all the water it can hold. That which falls after the forest floor is saturated runs into the streams almost as fast as it would over bare ground.

From: Gifford Pinchot, A Primer for Forestry, 1905

The Himalayan sponge

The Himalayan forests normally exert a sponge effect, soaking up abundant rainfall and storing it before releasing it in regular amounts over an extended period. When the forest is cleared, rivers turn muddy and swollen during the wet season, before shrinking during drier periods.

From: Myers 1986

Forests, regulation of stream flow and flood prevention

It is commonly believed that forests are necessary to regulate stream flow and reduce runoff, and to some extent this is true. But, in reality, forests tend to be rather extravagant users of water, which is contradictory to earlier thinking (FAO 2003). Considerable quantities of rainfall (up to 35 per cent) are commonly intercepted by the canopies of tropical forests and evaporated back into the atmosphere without contributing to soil water reserves. Much of the water that does soak into the soil is used by the trees themselves. This should put to rest the belief that extensive reforestation or afforestation will increase the low flows in the dry season (Hamilton and Pearce 1987). Therefore, replacing forest cover with other land uses almost always results in increased runoff and stream flow. Runoff and stream-flow patterns will gradually return to original levels if an area is left to revert back to forest. Converting forest to grasslands, however, will normally result in a permanent increase in total water runoff.

Contrary to popular belief, forests have only a limited influence on major downstream flooding, especially large-scale events. It is correct that on a local scale forests and forest soils are capable of reducing runoff, generally as the result of enhanced infiltration and storage capacities. But this holds true only for small-scale rainfall events, which are not responsible for severe flooding in downstream areas. During a major rainfall event (like those that result in massive flooding), especially after prolonged periods of preceding rainfall, the forest soil becomes saturated and water no longer filters into the soil but instead runs off along the soil surface.

Studies in America (Hewlett and Helvey 1970), and South Africa (Hewlett and Bosch 1984) were amongst some of the first to question the importance of the link between forest conversion and flooding. Studies in the Himalayas indicate that the increase in infiltration capacity of forested lands over non-forested lands is insufficient to influence major downstream flooding events (Gilmour *et al.* 1987; Hamilton 1987). Instead, the main factors influencing major flooding given a large rainfall event, are: (i) the geomorphology of the area; and (ii) preceding rainfall (Bruijnzeel 1990, 2004; Calder 2000; Hamilton with King 1983; Kattelmann 1987).

Yielding insights into water yields

No experiments, with the exception of perhaps one, have resulted in reductions in water yield with reductions in cover, or increases in yield, with increase in cover.

From: Bosch and Hewlett 1982

Even at the local level, the regulating effect depends mostly on soil depth, structure and degree of previous saturation. Thin soils produce ‘flashy’ flows (quick responses). Massive programmes of forestation that have often been proclaimed as ‘the answer’ to preventing floods simply will not do the job, although there may be many other benefits from reforestation (Hamilton and Pearce 1987).

Erosion and sedimentation

It is widely perceived that forests can control erosion and sediment processes. While forest cover does tend to check erosion, it is not the tree canopy that is directly responsible for this; rather it is the undergrowth and forest litter. Experiments indicate that the erosive power of raindrops under trees actually tends to be very high because the raindrops merge before dripping off the leaves and therefore hit the ground with greater force (Wiersum 1985; Hamilton 1987; Brandt 1988). This sometimes leads to particularly serious erosion problems in plantations where the soil has been cleared of vegetation and litter to reduce fire hazard or where litter is collected for livestock bedding or fuel. If the soil surface is adequately protected by a well-developed litter layer and complete vegetative cover, other vegetation types can offer equivalent protection against erosion, but with the added advantage of lower water use.

Land degradation and soil erosion that are often associated with the loss of forest cover are not necessarily the result of the forest removal itself, but of the poor land-use practices (overgrazing, litter removal, destruction of the organic matter, clean weeding) implemented after forest removal (Bruijnzeel 1991, 2004; Hamilton with King 1983). Also, much of the erosion that occurs after timber harvesting is due to the movement of soil during logging operations (e.g., road construction, skidding, etc.). Compaction results in lower water storage capacity of the soil and increased surface runoff. Many of these negative effects can be significantly diminished by applying reduced impact logging (RIL) techniques.

Environmental benefits of reduced impact logging (RIL)

- On average, RIL results in 41 per cent less damage to residual stands when compared with conventional logging systems.
- The area covered by skid trails in RIL operations is almost 50 per cent less than in conventional logging, even for similar volumes extracted.
- The area damaged by road construction is about 40 per cent less with RIL than with conventional logging.
- Overall site damage (compaction, exposure of soil, etc.) in RIL operations is generally less than half that in conventional logging.
- Canopy opening is generally about one-third less in RIL compared with conventional harvesting practices (16 per cent versus 25 per cent).

From: Killmann et al. 2002

Landslips, too, may occur due to the loss of forest cover. Tree roots play an important role in slope stability and can indeed give the soil a certain amount of mechanical support, but this is limited to shallow (<1m) mass movements (Bruijnzeel 1990, 2002; O'Loughlin 1974). This type of landslide is quickly stabilised and does not usually result in high amounts of sediment entering the surrounding rivers.

Deep-seated (>3m) landslides, on the other hand, are not noticeably influenced by the presence or absence of a well-developed forest cover (Bruijnzeel 1990, 2002). Such events are most influenced by geological, topographical and climatic factors, rather than by forest cover (Ramsay 1987).

Impacts of scale on flooding

Research on the effects of land-use changes on flooding is usually conducted in small headwater catchment areas (e.g., 100-1,000 hectares) and frequently considers the effects of only a single change in vegetative cover (e.g., from forest to grassland), such as the landmark Coweeta experiments in the United States (Douglass and Swank 1975). Such experiments do not adequately take into account the multiple land uses found over entire watersheds. Therefore, extrapolation of research results obtained in sub-watershed areas to entire watersheds is inappropriate and misleading. A review of past research indicates that land-use effects on flooding were observable only in relatively small basins (Table 1). In basins larger than 50,000 hectares, the effects of flooding tend to be averaged out across the different sub-basins as storms pass over. Since the flood waves from the different sub-basins do not usually reach the main basin area simultaneously, there may be little or no cumulative effect from the individual flood waves.

Experts agreeing on what is needed

Much is known about hydrological processes in forests at a small catchment scale. However, there is a critical need to initiate and strengthen long-term eco-hydrological monitoring for further research to improve understanding of large-scale interactions and the influence of forests on dry season flows, flood mitigation and groundwater recharge in a range of environments in line with paragraph 27 of the WSSD Plan of Implementation.

From: Shiga Declaration on Forests and Water, 2002

When major floods do occur, it is most often towards the end of the rainy season, when heavy rain falls in a number of sub-basins (simultaneously) and usually on soils that are already saturated and therefore incapable of soaking up additional water. The extent and severity of wide-scale flooding can be further intensified by the occurrence of torrential rains in the floodplains or the river surfaces themselves during vulnerable periods. This can be further exacerbated by high tides, which frequently happen in Bangkok, Dhaka and other low-lying cities.

Table 1: The spatial dimension of land-use effects

Impact	Basin size [km²]						
	0.1	1	10	100	1,000	10,000	100,000
Average flow	x	x	x	x	—	—	—
Peak flow	x	x	x	x	—	—	—
Base flow	x	x	x	x	—	—	—
Groundwater recharge	x	x	x	x	—	—	—
Sediment load	x	x	x	x	—	—	—
Nutrients	x	x	x	x	x	—	—
Organic matter	x	x	x	x	—	—	—
Pathogens	x	x	x	—	—	—	—
Salinity	x	x	x	x	x	x	x
Pesticides	x	x	x	x	x	x	x
Heavy metals	x	x	x	x	x	x	x
Thermal regime	x	x	—	—	—	—	—

Legend: x = Observable impact; — = no observable impact
Adapted from Kiersch (2001).

Frequency of floods

Although some studies have shown apparent increases in flooding over time, such studies have tended to look at relatively short timeframes and limited data sets (Bruijnzeel 1990). When considering longer timeframes, cycles are revealed within which major flooding tends to occur at fairly regular intervals. These cycles appear to be driven by major climatic patterns (e.g., those resulting from the influence of cyclical warm ocean currents).

Examining the historical patterns of catastrophic events reveals that floods, as well as droughts, are not a recent phenomenon by any means. For example, major floods in the Bangkok metropolitan and adjacent areas have been recorded regularly for the last 200 years. Large-scale floods in the Chiang Mai valley in northern Thailand are well documented for events in 1918-1920 and again in 1953. These floods all occurred when lush forests were still abundant in Thailand. Eight major floods were recorded in Bangladesh between 1870 and 1922. A study on floods in Bangladesh concluded that 'there is absolutely no statistical evidence that the frequency of major flooding has increased over the last 120 years' (Hofer and Messerli 1997).

Perceptions of the destructive power and severity of floods

Settlements have always been established on floodplains, despite the risk of periodic flooding. The numerous social, economic and environmental benefits of living near water have historically outweighed the risks of floods. Most early settlements were located on the higher areas of floodplains, which helped to minimise risks and potential damage from floods. As towns and cities grew, however, new housing areas and commercial estates expanded into the more flood-prone areas that had previously been avoided.

The development of urban areas also transformed formerly vegetated land to impermeable surfaces, with little or no water storage capacity. Extensive areas of wetlands that once acted as natural retention and storage areas for floodwaters were drained, filled and built upon. Natural stream channels were straightened and deepened, and structures such as dams and embankments were commonly built to reduce local flood risks.

These ‘solutions’ may have served to help reduce flood impacts locally but have often had the effect of shifting the problem further downstream, rather than solving it. This pattern has been exacerbated by the removal of the natural storage functions of the floodplain. Today’s floodplains bear little resemblance to yesterday’s floodplains, and it should not be a surprise therefore that even minor floods can nowadays cause major damage.

The severity of floods is often measured and described in terms of economic losses rather than physical parameters. This approach can easily give the impression that flooding has become much more severe in recent times. In reality, the huge economic losses attributed to flooding in recent years are mainly a reflection of expanding economic growth, increased investment in infrastructure and rapidly growing floodplain populations. Although the escalating economic costs of floods underscore the urgent need for improved floodplain management and disaster mitigation, it is incorrect to conclude that floods are any more frequent (in physical terms) now than in the past.

Recognising the dilemma!

Within river systems, flooding is the natural way for the system to discharge the water arising from the occasional large rainfall event. There is no problem at all until man decides to use some of the natural flood plain for his own use, and chooses to protect against inundation. We then face the dilemma of protecting against a natural hazard for the benefit of mankind that has chosen to live and work in flood plain areas.

From: Learning to live with rivers, Institute of Civil Engineers, 2001

Although humans do not directly cause floods, we have sometimes greatly exacerbated the problems caused by floods. Not only do many cities have inefficient water-drainage systems, local land subsidence makes recent floods appear worse than past events. For example, due to excessive and long-term groundwater withdrawal, Bangkok is sinking at an average of 2 cm every year. Since the city's elevation is between 0 and 1.5 m above sea level, it is not surprising that high tides can inundate major parts of the city, especially when they coincide with heavy rains. Other cities suffer similar problems. Moreover, the large increase in non-absorbing surfaces that goes with urban growth exacerbates the problem, speeding surface runoff, and allowing less infiltration.

Going under

Pumping of groundwater is one of the main causes for land subsidence, which has resulted in deeper flooding and longer water logging.

From: Pramote Maiklad 1999

The media also plays a significant role in shaping perceptions of the intensity, frequency and severity of flooding. Modern television news networks, in particular, can record and broadcast news of catastrophes far more quickly and comprehensively than anytime in history. While major flooding events of the past often went completely unreported, or were described only sketchily, perhaps months after their occurrence, modern media has the capacity to report extensively on flood disasters occurring anywhere in the world within hours. This capacity of the media, coupled with journalists' penchant for sensationalising news events — particularly disasters — can easily lead people to conclude that floods are occurring more frequently and with greater severity than in the past. Scientific evidence, however, does not support such conclusions.

For intensively developed urban areas and floodplains, land-use planning and control measures have an important role to play in flood mitigation (Moosan City, Kyungkido Province, Republic of Korea) (courtesy of the Farmland Rearrangement Division, Ministry of Agriculture and Forestry, Republic of Korea through Water Resources Section, UNESCAP)

Policy implications

Disentangling facts from fiction related to catastrophic floods should point policy-makers towards a broader perspective than simply focusing on the uplands. The most important policy conclusion is a cautionary one. The role of forests in solving flood problems remains uncertain, although the progress that has been made in understanding upland-lowland interrelationships suggests that forests are much less important than commonly perceived. However, close to the forests in the uplands, they can reduce flooding from frequent, low-intensity, short-duration storms (Hamilton 1986). While it may be convenient to blame upland farmers and poor forest management for problems that affect low-lying areas, it unfortunately does not contribute to solving the problems.

Sound science provides little evidence to support anecdotal reports of forest harvesting or rural land-use practices leading to lower-basin catastrophic floods. When it comes to prevention of major floods, the 'sponge theory' is a historical *erratum* — a fiction often inappropriately used to justify soil and water conservation measures, forest management controls and logging bans. Unfortunately, the 'sponge theory' has also been used inappropriately to secure funds for various development and governmental projects. Simplistic belief in the flawed approach to flood management distracts the attention of policy-makers from two main points:

1. There are many good reasons — other than for avoiding floods — for protecting soils in Asia's uplands and for managing upland forests sustainably.
2. Instead of pointing to distant uplands as the source of their problems and dwelling on fictional cause-effect relationships, lowlanders (including policy-makers) should learn to live with rivers and manage the lowlands for what they are — floodplains.

For several days volunteers in boats had to rescue men and women trapped on roof tops during Jakarta's devastating floods in February 2002 (photo by Arie Basuki)

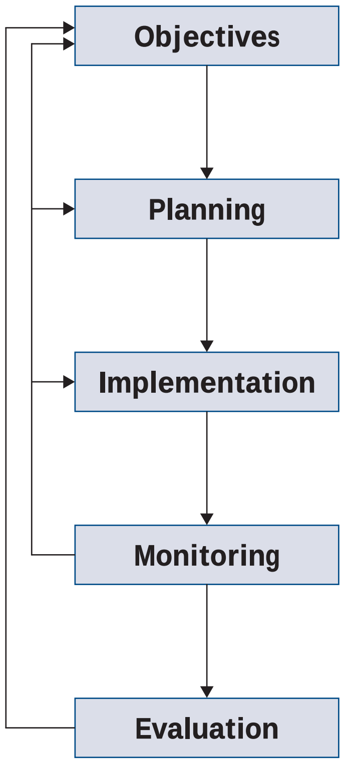
Taking an integrated approach

Although forests can play a certain role in delaying and reducing peak floodwater flows at local levels, scientific evidence clearly indicates that forests cannot stop catastrophic large-scale floods, commonly caused by severe meteorological events — the type of events that are often blamed on forest harvesting or conversion to agricultural uses. This in no way diminishes the need for proper management and conservation of upland forests. But it does point toward the critical need for integrated approaches in river-basin management that look beyond simplistic forest-based 'solutions'. To be successful, such integrated approaches must combine various measures in the uplands with those in the lowlands, and work with natural processes and not against them.

An integrated approach to river-basin management recognises the limitations of working only in the uplands to minimise floods or only in the lowlands to reduce their damage. It takes into account that soils of well-managed natural forests and plantations can maintain a higher water-storage capacity than most non-forest soils under similar conditions. They can thus slow the rate of runoff, which in turn helps to minimise flooding in smaller watersheds and of more frequent intermediate events. It also does justice to the multitude of other environmental services that forests provide. Furthermore, an integrated approach recognises that forest conservation and appropriate management are not only important in the upper reaches of Asia's watersheds but also in the river basins, where the forests form an important component of wetland ecosystems. Moreover, it recognises the role of maintaining forests on key sites to reduce sediment problems, such as on slip-prone soils and in riparian zones.

This approach integrates land-use management in the uplands with land-use planning, engineering measures, flood preparedness and emergency management in the lowlands. It considers the social and economic needs of communities living in both the mountainous watersheds and the river basins. Integrated management has to be based on the best available scientific knowledge of the causes and the environmental, social and economic impacts of floods. Essentially, this approach should prepare people to live with and adapt to rivers and floods.

Such an integrated management system is the result of an iterative process (Figure 1), which without doubt has many challenges resulting from the trans-boundary nature of major river systems such as the Ganga-Brahmaputra-Meghna Basin. It is also complicated by the large number of different stakeholders who often have very different views on how the problem should be solved, and by the many conflicting uses of the precious resources within a basin.



Objectives are formulated for the management of the entire basin (watershed and floodplain) on the basis of local and national needs by means of intensive stakeholder consultation.

A plan for the management of the basin is formulated on the basis of the objectives, the land-use and resource management needs of the area. This is done through intensive stakeholder participation.

The plan is implemented by all landowners and concerned stakeholders under the guidance of a management board supported by appropriate policy instruments and innovative financing.

Implementation of the plan is closely monitored to asses the impact of interventions and policies. If necessary, interventions can be adapted on the basis of the monitoring results.

The implementation of the plan is evaluated on a regular basis to ensure that the objectives are being achieved. If necessary, the objectives can be adjusted in light of new knowledge or a change in user needs.

Figure 1: The iterative process of integrated basin management.

Under the integrated approach, the objectives for the management of the basin are initially formulated for both the lower and upper basin areas. These objectives should be based on local and national priorities, prevailing land uses and the unique characteristics of each basin's natural resources. Based on the defined objectives, management plans are formulated for entire basins — which may cross national borders — in close consultation with all stakeholders. The management plan details the activities required to achieve the desired objectives. Planning is appropriately done at two levels — watershed and floodplain — and then integrated to form a cohesive overall management plan (see for example Easter *et al.* 1986).

The management plan comprises all the activities required to organise land and other resource use within a watershed in the course of providing the goods and services defined by the objectives, while at the same time maintaining and supporting the livelihoods of resident populations. The plan is implemented by all landowners and concerned stakeholders under the guidance of appropriate management bodies and supported by pragmatic policy instruments and innovative financing mechanisms. Examples of such bodies include several river-basin commissions in the United States of America and the United Kingdom, the Murray-Darling River basin Commission in Australia, the Rhine and Danube Commissions in Europe, the Red River Basin Commission that links Canada with the USA, and the Mekong River Commission whose member countries are Cambodia, Lao PDR, Thailand and Viet Nam.

Incentives need to be offered to encourage desired land uses and land-management practices and to align private interests with the public good. Compensation needs to be provided to land users negatively affected by the plans. The results of the implementation are monitored and impacts of various policy instruments and interventions assessed, to ensure that the objectives are being achieved and that costs and benefits are equitably shared. The entire process is evaluated on a regular basis and, if necessary, objectives or activities can be adjusted to meet new requirements or expectations. Management objectives can change over time as priorities and land-use practices evolve. This is a dynamic process that ensures, through the various feedback mechanisms, that objectives remain realistic and can be reached without causing unacceptable and unmanageable environmental and socio-economic impacts.

Floods after heavy rain in May 2003, Ranna, Hambantota District, Sri Lanka (photo by Sophie Nguyen Khoa, IWMI)

Towards more effective watershed management

To date, watershed management has generally achieved only partial success, largely due to the fact that biophysical factors have been emphasised at the expense of socio-economic concerns and the fact that hydrologic boundaries are not congruent with political boundaries. To be seen as responding to flooding problems, government officials and development agencies regularly launch new watershed-management programmes and projects. The activities under these initiatives typically focus on maintaining or expanding forest cover and encouraging soil and water conservation practices in agricultural areas. Attention is also usually given to curtailing shifting cultivation and stabilising rural settlements. However, sporadic short-term efforts in soil and water conservation and reforestation on individual plots (selected on the basis of farmers' willingness to participate or direct payments for co-operation) are unlikely to have a discernible flood mitigation effect, even at the level of a small watershed.

Although these types of projects can be beneficial on a local scale, they are not likely to contribute significantly to flood mitigation as a whole. They may, however, contribute to reducing sedimentation, which has adverse effects on aquatic life, reservoir life, potable water quality, irrigation quality and navigation (Hamilton and Pearce 1986).

Watershed management that is heavily reliant on improved farming technologies often ignores the many water resource-related problems that are caused by non-agricultural land uses. Mining and physical infrastructure such as roads, for example, can affect local hydrology far more than agricultural practices, and can lead to uncontrolled runoff and sedimentation of rivers. Effective watershed management identifies the main problem areas or 'hot spots' of risk and sets appropriate priorities for mitigative interventions. Under this approach, there is no pre-determined assumption that agriculture and farmers (or forestry and loggers) are the major sources of problems.

Effective watershed management is an iterative process of evaluating, planning, restoring and organising land and resource use within a watershed to provide desired goods and services while maintaining and supporting the livelihoods of resident populations. This process provides an opportunity for stakeholders to balance diverse goals and resource uses, and to consider how their cumulative actions may affect long-term sustainability of natural resources. Embedded in the concept of watershed management is the recognition of the interrelationships of many different activities such as fisheries, urban development, agriculture, mining, forestry, recreation, conservation and other human influences, as well as the linkages between upstream and downstream areas.

An important aspect of watershed management is land-use classification and land-use planning. It is vital that the fragile areas be identified and protected from inappropriate use, whether forestry, agriculture or mining. However, even the 'best' plan will have no impact if its implementation is not facilitated by supportive policies, a regulatory framework providing guidance, and incentive systems stimulating behaviour that benefits the watershed and society at large.

What can be expected from forest and soil conservation?

Forestation of mountain watersheds and extensive soil conservation measures are valuable for the sake of the hill farmers, if appropriately carried out. It is potentially disastrous, however, for foreign aid agencies and national government authorities to undertake such activities with the conviction that they will solve problems in the plains.

From: Lauterburg 1993

Although watershed classification, planning and management are usually the domain of foresters (or soil conservationists), the profession falls short in recognising that forest management itself — if not practised appropriately — can produce substantial on- and offsite costs. Poor logging practices generate massive quantities of sediments and can substantially influence local stream-flow patterns, especially through increased runoff from landings, skidtrails and logging roads. Thus, effective watershed management also means introducing reduced impact logging, enforcing logging guidelines and adhering to codes of practice for forest harvesting. In addition, riparian forests should be managed rigorously to protect water quality. This is an area where unambiguous research results point to significant environmental benefits.

Unfortunately, the benefits of these techniques are not fully recognised and related practices are not utilised to their full potential. Many logging companies still consider reduced impact logging merely in terms of increased operating costs with no additional economic gains. In the absence of rigorous regulation and targeted incentives, such attitudes typically result in limited application of improved logging practices.

Effective watershed and forest management consistently yield significant environmental services, including high-quality fresh-water supplies. However, the influence of watershed and forest management practices on stream-flow patterns is relatively small, and is mainly limited to watersheds up to 500 km^2 in area. As such, forests alone will not be able to protect entire river basins from catastrophic events. Even with the best intentions, no amount of watershed management interventions will prevent major flooding events, although there are some definite benefits at the local scale.

Flooding in Tonle Sap area of Cambodia inundates agricultural lands (courtesy of Mr Ty Sokhun, Forest Management Office, Department of Forestry and Wildlife, Cambodia through Water Resources Section, UNESCAP)

Towards more effective floodplain management

Effective floodplain management, like watershed management, is an iterative process of identifying and assessing alternative ways of reducing the impact of floods (particularly of catastrophic events) in flood-prone areas. Decision-making in floodplain management involves compromises between the costs and benefits of alternative actions. It also requires that upper catchment areas be considered part of the solution and not as the 'source' of the problem.

What is floodplain management?

Floodplain management refers to all the actions society can take to responsibly, sustainably, and equitably manage the areas where floods occur and which serve to meet many different social, economic, natural resource and ecological needs. Since this includes reducing the hazard and suffering caused by floods, floodplain and flood management consist of many common activities. However, floodplain management recognises explicitly that other factors of a social, economic, natural resource management and ecological nature also have to be taken into account in "managing" floods.

From: Mekong River Commission, 2001

In the past, structural responses (e.g., dams, levees, dikes, etc.) were emphasised and, indeed, in the early- to mid-20th century engineers prevailed in debates over the best means to tame the awesome power of floodwaters. With 'flood control' as their explicit objective, engineers around the world spent decades (and billions of dollars) building dams, embankments and levees to prevent floodwaters from inundating floodplains. These structures were often combined with dredging to straighten and deepen stream channels. According to the World Commission on Dams (WCD 2000), some 13 per cent of all large dams, or over 3,000 worldwide, were built with a specific flood-mitigation function.

Most flood defences were built as individual local schemes, with little consideration of their impacts across the wider river catchment, their impacts on the aquatic and coastal environments or, indeed, even their broad economic impacts. The fact that

Can floods be controlled?

"Flood control" is a common expression… But one cannot control floods; at best one can manage their detrimental effects. The words "flood control" are therefore not used in this report.

From: Mekong River Commission, 2001

embankments and other engineering structures were most effective only for small- to medium-sized flood events was often not recognised. Also, river, road and other embankments sometimes inhibited the discharge of rainwater from water-logged areas into the river system (particularly where the number of sluices in the embankments is insufficient) and accordingly increased the dimension of flooding.

The available water storage of a typical reservoir is generally much less than the volume of a major flood surge. Moreover, structural solutions often have spill-over effects, shifting problems from one location to the next. For example, emergency releases of water during periods of high rainfall can dramatically and dangerously increase water levels immediately downstream of dams.

Experiences with embankments in Bangladesh

The Brahmaputra embankments channel the flood waters of the river, preventing the river from overflowing. In 1987, however, this had serious consequences for the left, unembanked side of the river: The water spread out and inundated large areas, and erosion on the left river bank increased dramatically.

From: Hofer and Messerli 1997

It should be evident that individual flood alleviation schemes cannot be considered in isolation and that a solution in one part of a river basin may be detrimental for other areas further downstream. Recently, numerous restoration projects have been implemented to reverse the impacts of earlier engineering works such as the Rhine Action Plan on Flood Defence adopted in 1998 after major floods in 1993 and 1995 (Leentvaar 1999). Increasingly, management of flood risks is moving away from structural engineering solutions toward programmes that work with natural processes. The impetus for this shift came from a number of major destructive events over the last 50 years, including:

- 1953 coastal flooding in the Netherlands that led to the Delta works;
- 1988-9 floods in Bangladesh that led to the Flood Action Plan and the National Water Management Plan;

- the upper Mississippi floods of 1993;
- the Rhône floods of 1993;
- the Rhine floods of 1993 and 1995;
- the Yangtze floods of 1998 in China; and
- the Elbe floods in Europe in 2002 — which once again drew attention to the important role of non-structural catchment measures.

The new approach weighs alternative actions in floodplain management in the context of whether overall flood effects are positive or negative. Although attention is usually focused on the negative effects of floods, there are highly important positive effects that warrant recognition and consideration. Flooding in many low-lying areas in Asia is a vital element of the culture and economy of the people. Annual floods along many rivers carry fine sediments and nutrients that renew the fertility of the land and aquatic habitats, and the continuous flow of silt-bearing irrigation water helps control diseases in many areas. In a region where agriculture and fishing remain vitally important, the loss of these beneficial effects could potentially lead to unacceptable economic and social disruption. However, what is beneficial to some may inflict heavy economic costs upon others. The challenge is to balance costs and benefits.

The positive effects of flooding

During a normal flood [in Bangladesh] the fields are inundated and alluvial organic matter is deposited. Normal floods are necessary for important monsoon crops.

From: Hofer and Messerli 1997

New flood management approaches are steadily introducing or expanding the role of non-structural measures within integrated floodplain management programs. Key measures include the identification of natural storage areas, such as swamps and wetlands, where excess water can be directed and temporarily stored during periods of flooding. The World Commission on Dams (WCD 2000) categorises the components of an integrated approach to floodplain management according to those which reduce the scale of floods, those which isolate the threat of floods and those which increase people’s capacity to cope with floods (Table 2).

A similar approach is also evident in the Mekong River Commission’s (MRC 2001) promotion of ‘Integrated Floodplain Management’, which comprises a mix of four types of management measures. These reflect the flooding, flood risk and flood hazard characteristics of a particular floodplain, the specific social and economic needs of flood-prone communities, and the environmental and resource management policies for the floodplain.

Table 2: Complementary approaches of integrated flood management

Reducing the scale of floods	Isolating the threat of floods	Increasing people's coping capacity
Better catchment management Controlling runoff Detention basins Dams Protecting wetlands	Flood embankments Flood proofing Limiting floodplain development	Support traditional strategies Emergency planning Forecasting Warnings Evacuation Compensation Insurance

Source: World Commission on Dams (2000)

Integrated Floodplain Management on the Mekong River

Land-use planning measures are aimed at "keeping people away from the floodwaters." Land-use measures on the floodplain aim to ensure that the vulnerability of a particular land-use activity is consistent with the flood hazard on that area of land.

Structural measures are aimed at "keeping floodwaters away from the people." Typical structural measures include flood mitigation dams, embankments and flood detention basins.

Flood preparedness measures recognize that — no matter how effective the above types of management measures are — an overwhelming flood will eventually occur. These measures embody flood forecasting, flood warning, and raising the general flood awareness of the potentially affected population groups. In a number of cases, flood preparedness and emergency measures may be the only type of management that is feasible or economically justified.

Flood emergency measures deal with the aftermath of major events by "helping affected people to cope with floods." Flood emergency management, like floodplain management, is a process that typically encompasses preparation, response and recovery. The process embodies evacuation planning and training, emergency accommodation planning, flood cleanup, restitution of essential services, and other social and financial recovery measures.

From: Mekong River Commission, 2001

The importance of regional co-operation has also been stressed by the South Asian Floods Project (SAF) of the International Centre for Integrated Mountain Development. The project facilitates information exchange in the Hindu Kush-Himalayan region (http://www.southasianfloods.org). It stresses that one of the most cost-effective means of reducing the impact of floods is the non-structural approach of providing people with sufficient advance warning for them to escape from approaching disasters. It further points out the importance of timely and reliable information on weather and river flows, and the open exchange of information among countries. Priority needs to be given to the development of such information gathering and dissemination networks in countries where no such systems currently exist.

Finally, there is a clear need to develop improved capacities for river systems to respond to flooding in both rural and urban environments, and by balancing land use more carefully. Agricultural and forestry policies, practices and incentive schemes need to be redirected towards reduction of flood risks and the restoration of the roles of formerly undeveloped floodplains for storing water and reducing peak flows downstream. Indeed, flood storage could become a recognised land use in development plans, which should be encouraged and compensated through government incentives. For example, over 25,000 homes have been relocated from the Mississippi floodplain since 1993, and thousands of hectares of marginally productive low-lying areas have been reconverted from agriculture to natural areas (Galloway, Jr. 1999).

Reversing the past

In the future, drainage design should reverse the past 200 years of engineering practice. Storage should be maximized and conveyance minimized. Post-modern drainage design should mimic the form and performance of the pre-settlement drainage system.

From: Hey 2001

Urban flood in Bangkok, Thailand (courtesy of the Royal Irrigation Department of Thailand through Water Resources Section, UNESCAP)

A healthy mountain watershed
in Kashmir, Indian Himalaya
(photo by Thomas Hofer)

Making rational policy decisions

Flood processes in Asia are highly complex. Only integrated approaches take this complexity sufficiently into account and lead to adaptive and effective flood management. An improved approach to watershed and floodplain management integrates land management in the uplands with land-use planning, engineering solutions, flood preparedness and emergency management in the lowlands. This requires good understanding of all the physical processes involved, as well as the social behaviour and culture of local residents. Furthermore, this approach should draw upon the best available scientific knowledge about the environmental, social and economic impacts of floods and the environmental, social and economic effects of interventions.

The myths and misperceptions about the causes of flooding that have misguided decision-makers, planners and managers alike need to be replaced by rational understanding based on facts. Too many local, national and international agencies have used ‘conventional wisdom’ and unsupported claims to advance their own institutional interests and because it has been politically advantageous to channel aid funds to upland reforestation and conservation projects. The media has unfortunately perpetuated many of the myths regarding forests and floods out of a well-intentioned, but ill-informed, desire to protect the environment, especially the forests of upper watersheds.

It should be clear that large-scale reforestation programmes, the adoption of soil and water conservation technologies in agriculture, logging bans and the resettlement of upland people to lowland areas will *not* significantly reduce the incidence or severity of catastrophic floods. Positive environmental impacts from these interventions will be of a local nature, while the negative social and economic impacts are likely to be more widespread.

Importantly, the habit of blaming upland inhabitants for catastrophic floods of whole river basins must be abandoned. Instead, practical solutions are needed to redress watershed degradation caused by unsustainable land-management practices, including poor logging practices and inappropriate infrastructure development. While refraining from exaggerating the negative impacts that mountain people have on the environment, we should also not overstate the positive impacts of their participation in watershed management programmes, as is happening with some recent attempts to develop markets for the environmental services that forests may provide. Moreover, policy-makers and development agencies have a moral and ethical responsibility to ensure that regulatory and project approaches are based on the best available scientific knowledge and do not unnecessarily place upland communities at risk of further impoverishment.

The scope of forestry in mitigating floods

...the scope for forests to reduce the severity of major floods that are derived from an extended period of very heavy rainfall is rather limited.

From: UK Forestry Commission, 2002

While the ability of forests to prevent catastrophic floods is limited, watershed management should definitely not be abandoned. Forests provide a variety of environmental services, which need to be protected and nurtured for the benefit of today's and tomorrow's upland and lowland populations. Watershed management needs to consider the needs and interests of local populations, but should also account for the needs of the wider society.

The most effective approaches to reducing damage caused by catastrophic floods require a strong focus on downstream areas and floodplains. People in these areas need to 'learn to live with rivers', as the UK Institution of Civil Engineers entitled its 2001 report on flood mitigation measures. At the same time, politicians and policy-makers need to abandon their belief in quick fixes for flood-related problems. While the high costs of floods in the lowlands of Asia are evident, it is important that the beneficial aspects of floods are also acknowledged. It is only by promoting and supporting comprehensive integrated watershed and floodplain management that the needs and aspirations of all residents — uplanders and lowlanders — can be adequately addressed.

Bibliography

Alford, D. 1992. Streamflow and sediment transport from mountainous watersheds of the Chao Phraya Basin, Northern Thailand: a reconnaissance study. *Mountain Research and Development* 12: 257-68.

Bosch, J.M. and Hewlett, J.D. 1982. A review of catchment experiments to determine the effects of vegetation changes on water yield and evapotranspiration. *Journal of Hydrology* 55: 3-23.

Brandt, J. 1988. The transformation of rainfall energy by a tropical rainforest canopy in relation to soil erosion. *Journal of Biogeography* 15: 41-8.

Brooks, K. N., Ffolliott, P. F., Gregersen H. M. and DeBano, L.F. 2003. *Hydrology and the Management of Watersheds.* Third Edition. Iowa State Press, Ames, Iowa.

Brooks, K. N., Gregersen, H. M., Lundgren, A. L., Quinn, R. M. and Rose, D. W. 1989. *Watershed Management Project Planning, Monitoring, And Evaluation: A Manual for the ASEAN Region.* ASEAN-US Watershed Project, Philippines.

Bruijnzeel, L.A. 1990 *Hydrology of Moist Tropical Forests and Effects of Conversion: A State of Knowledge Review*. Humid Tropics Programme, UNESCO International Hydrological Programme, UNESCO, Paris.

Bruijnzeel, L.A. 2004. Hydrological functions of tropical forests: not seeing the soil for the trees? *Agriculture Ecosystems and Environment* 104(1): 185-228.

Calder, I.R. 1999. *The Blue Revolution, Land Use and Integrated Water Resources Management*. Earthscan, London.

Calder, I.R. 2000. Land use impacts on water resources. Background paper 1. *In*: FAO Electronic Workshop on Land-Water Linkages in Rural Watersheds, 18 September-27 October 2000. http://www.fao.org/ag/agl/watershed/.

Calder, I.R. 2004. Forests and water — closing the gap between public and science perceptions. *Water Science and Technology* 49(7): 39-53.

Calder, I.R., Amezaga, J., Aylward, B., Bosch, J., Fuller, L., Gallop, K., Gosain, A., Hope, R., Jewitt, G., Miranda, M., Porras, I. and Wilson, V. 2004. Forest and water policies — the need to reconcile public and science perceptions. *Geologica Acta* 2(2): 157-66.

Douglass, J.E. and Swank, W.T. 1975. Effects of management practices on water quality and quantity: Coweeta Hydrologic Laboratory, North Carolina. In: *Municipal Watershed Management Symposium Proceedings*, USDA Forest Service Technical. Report. NE-13, Upper Darby PA, USA.

Dwyer, J.P., Wallace, D. and Larson, D.R. 1997. Value of woody river corridors in levee protection along the Missouri River in 1993. *Journal of the American Water Resources Association* 33(2): 481-9.

Easter, K.W., Dixon, J.A. and Hufschmidt, M.M. 1986. *Water Resources Management: An Integrated Framework with Studies from Asia and the Pacific*. Westview Press Studies in Water Policy and Management No.10, Boulder CO, USA

FAO. 2003. *State of the World's Forests*. Food and Agriculture Organization of the United Nations, Rome.

Fitzpatrick, F.A., Knox, J.C. and Whitman, H. E. 1999. *Effects of Historical Land-cover Changes on Flooding and Sedimentation, North Fish Creek, Wisconsin*. USGS Water Resources Investigations Report 99-4083. U.S. Geological Survey, Middleton, Wisconsin.

Forsyth, T. 1998. Mountain myths revisited: Integrating natural and social environmental science. *Mountain Research and Development* 18 (2): 107-16.

Galloway Jr., G.E. 1999. Two hundred and eighty years of river management and flood control along the Mississippi. In: *Regional Cooperation in the Twenty-first Century on Flood Control and Management in Asia and the Pacific*. Economic and Social Commission for Asia and the Pacific, Bangkok. pp. 190-204.

Gilmour, D.A., Bonell, M. and Cassells, D.S. 1987. The effects of forestation on soil hydraulic properties in the middle hills of Nepal: a preliminary assessment. *Mountain Research and Development* 7: 239-49.

Gregersen, H. M., Brooks, K. N., Dixon, J. A. and Hamilton L. S. 1987. *Guidelines for Economic Appraisal of Watershed Management Projects*. FAO Conservation Guide no. 16. Food and Agriculture Organization of the United Nations, Rome.

Hamilton, L.S. with King, P.N. 1983. *Tropical Forested Watersheds: Hydrologic and Soils Response to Major Uses or Conversions*. Westview Press, Boulder CO, USA.

Hamilton, L.S. 1985. Overcoming myths about soil and water impacts of tropical forest land uses. In: *Soil Erosion and Conservation*. Eds. El-Swaify, S.A., Moldenhauer, W.C. and Lo, A., Soil Conservation Society of America, Ankeny IA, USA, pp. 680-90.

Hamilton, L.S. 1986. Towards clarifying the appropriate mandate in forestry for watershed rehabilitation and management. In: *Strategies, Approaches and Systems in Integrated Watershed Management*. FAO Conservation Guide 14, Rome, pp. 33-51.

Hamilton, L.S. 1987 What are the impacts of deforestation in the Himalayas on the Ganges-Brahmaputra lowlands and delta? Relations between assumptions and facts. *Mountain Research and Development* 7: 256-63.

Hamilton, L.S. and Pearce, A.J. 1986. Biophysical aspects in watershed management. In: *Watershed Resources Management: An Integrated Framework with Studies from Asia and the Pacific*. Eds. Easter, K.W., Dixon, J.A. and Hufschmidt, M.M. Westview Press, Boulder CO, USA, pp. 33-52.

Hamilton, L.S. and Pearce, A.J. 1987. What are the soil and water benefits of planting trees in developing country watersheds? In: *Sustainable Development of Natural Resources in the Third World*. Eds. Southgate, D.D. and Disinger, J.D. Westview Press, Boulder CO, USA, pp. 39-58.

Hewlett, J.D. 1982. Forests and Floods in Light of Recent Investigations. *Proceedings of the Canadian Hydrology Symposium*; 14-15 June 1982; Fredericton, New Brunswick. Associate Committee on Hydrology, National Research Council of Canada, pp. 543-59.

Hewlett, J.D. and Bosch, J.M. 1984. The dependence of storm flows on rainfall intensity and vegetal cover. South Africa. *Journal of Hydrology*: 75: 365-81.

Hewlett, J.D. and Helvey, J.D. 1970. Effects of forest clearfelling on the storm hydrograph. *Water Resources Research* 6(3): 768-82.

Hey, D.L. 2001. Modern drainage design: the pros, the cons, and the future. Paper presented at the Annual Meeting of the American Institute of Hydrology, 14-17 October 2001, Bloomington, Minnesota.

Hofer, T. and Messerli, B. 1997. Floods in Bangladesh: Process understanding and development strategies. A synthesis paper prepared for the Swiss Agency for Development and Cooperation. Institute of Geography, University of Berne, Berne.

Ives, J.D. and Messerli, B. 1989. *The Himalayan Dilemma*. Reconciling development and Conservation. Routledge, London and New York.

Ives, J.D. and Ives, P., eds. 1987. The Himalaya-Ganges problem. Proceedings of a conference, Mohonk Mountain House, New Paltz, New York, USA, 6-11 April 1986. *Mountain Research and Development* (special issue), 7(3): 181-344.

Kattelmann, R. 1987. Uncertainty in assessing Himalayan water resources. *Mountain Research and Development* 7(3): 279-86.

Kiersch, B. 2001. Land use impacts on water resources: a literature review. Discussion Paper No.1. Land-water linkages in rural watersheds. Electronic Workshop. Food and Agriculture Organization of the United Nations, Rome.

Killmann, W., Bull, G.Q., Schwab, O. and Pulkki, R. 2002. Reduced impact logging: does it cost or does it pay. In: *Applying Reduced Impact Logging to Advance Sustainable Forest Management*, eds. Enters, T., Durst, P.D., Applegate, G., Kho. P.C.S. and Man, G., RAP Publication 2002/14. Food and Agriculture Organization of the United Nations, Bangkok. pp. 107-24.

Lauterburg, A. 1993. The Himalayan highland-lowland interactive system: do land use changes in the mountains affect the plains?

In: *Himalayan Environment Pressure-Problems-Processes 12 Years of Research*, eds. Messerli, B., Hofer, T. and Wymann, S. Geographica Bernensia, Berne.

Leentvaar, J. 1999. New development in flood control along the river Rhine. In: *Regional Cooperation in the Twenty-first Century on Flood Control and Management in Asia and the Pacific*. Economic and Social Commission for Asia and the Pacific, Bangkok. pp. 205-16.

Myers, N. 1986 Environmental repercussions of deforestation in the Himalaya. *Journal of World Forest Resource Management* 2: 63-72.

MRC, 2001. *MRC Strategy on Flood Management and Mitigation*. Mekong River Commission, Phnom Penh, Cambodia.

O'Loughlin, C.L. 1974. The effect of timber removal on the stability of forest soils. *Hydrology* 13: 121-34.

Pinchot, G. 1905. *A Primer of Forestry, Part II - Practical Forestry*, Bulletin 24, Part II. Bureau of Forestry, US Department of Agriculture, Washington, D.C.

Pramote Maiklad. 1999. Development and achievements in flood control and management in Thailand. In: *Regional Cooperation in the Twenty-first Century on Flood Control and Management in Asia and the Pacific*. Economic and Social Commission for Asia and the Pacific, Bangkok. pp. 59-111.

Rosgen, D.L. 1994. A classification of natural rivers. *CATENA* 22:169-99.

Rosgen, D.L. 1996. *Applied River Morphology*. Wildland Hydrology. Pagosa Springs, Colorado.

Thompson, M. and Warburton, M. 1986. Uncertainty on a Himalayan scale. *Mountain Research and Development* 5: 115-35.

UK Forestry Commission, 2002. *Climate Change: Impacts on UK Forests*. Forestry Commission, Edinburgh.

UK Institution of Civil Engineers. 2001. Learning to live with rivers. Final report of the Institution of Civil Engineer's Presidential Commission to review the technical aspects of flood risk management in England and Wales. UK Institution of Civil Engineers.

Wiersum, K.F. 1985. Effects of various vegetation layers in an Acacia auriculiformis forest plantation on surface erosion in Java, Indonesia. In: *Soil Erosion and Conservation*, eds. El-Swaify, S., Moldenhauer, W.C. and Lo, A., Soil Conservation Society of America, Ankeny, Iowa, USA. pp. 79-89.

WCD. 2000. *Dams and Development: a New Framework for Decision-Making*. Earthscan, London.

Verry, E.S. 2000. Water flow in soils and streams: sustaining hydrologioc function. In: *Riparian Management in Forests of the Continental Eastern United States*, eds. Verry, E.S., Hornbeck, J.W. and Dolloff, C.A. Lewis Publ., Boca Raton. pp. 99-124.

Forest Perspectives Series

1. - **Fast-Wood Forestry: Myths and Realities. 2003.**
     Christian Cossalter and Charlie Pye-Smith
   - **Fast-Wood Forestry: Myths and Realities (Japanese edition). 2005.**
     Christian Cossalter and Charlie Pye-Smith

There is a tendency to blame all natural disasters on human abuse of the natural environment. This is no more evident than in the case of devastating floods and landslides that affect the personal and economic fortunes of millions of people every year. Each disaster is followed by a predictable response. Upland farmers and loggers are blamed for clearing and degrading forests. In many people's minds the use and abuse of forests in upland watersheds represents the main cause of massive lowland floods.

Forests and floods: drowning in fiction or thriving on facts? explores the scientific evidence linking floods and forests. The booklet reveals that much of what is ingrained in people's minds cannot be substantiated by science and is often little more than myth or is patently incorrect. Such conventional wisdom has often led decision-makers to implement misguided policies that adversely affect the livelihoods of millions of people living in upland areas.

Forests and floods distinguishes fact from fiction and recommends alternative approaches for effective watershed and floodplain management. This authoritative overview has been produced by a suite of renowned experts, but it should appeal to everyone with an interest in escaping the quagmire of stale and dated paradigms. Ultimately, *Forests and floods* aims to better inform policy-makers, development agencies and the media, and so constructively contribute to the development of sound watershed and river-basin management and improved flood-mitigation policies.

Forest Perspectives **are published to promote discussion and debate on key forest issues. They are published by CIFOR as a service to encourage dialogue and information exchange among the international forest community. Electronic versions can be downloaded from CIFOR's web site (www.cifor.cgiar.org) and from FAO's web site (www.fao.or.th)**

FAO FIAT PANIS
CIFOR CENTER FOR INTERNATIONAL FORESTRY RESEARCH
IWMI International Water Management Institute
World Agroforestry Centre TRANSFORMING LIVES AND LANDSCAPES
ICIMOD
CGIAR
FUTURE HARVEST