Excerpted from Chapter 7
of *Silenced Rivers: The Ecology and Politics of Large Dams*
by Patrick McCully

The Wise Use of Watersheds

I do not see the reason why
You do not use what lies to hand
Before you try to dam our land . . .
Your pipes cry out for renovation.
Your storage tanks corrode and leak;
The valves are loose, the washers weak.
I've seen the water gushing out
From every reservoir and spout.
Repair them it will cost far less
Than driving us to homelessness . . .
But that's just one of many things:
Plant trees; revive your wells and springs.
Guide from your roofs the monsoon rain
Into great tanks to use again.
Reduce your runoff and your waste
Rather than with unholy waste
Destroying beauty which, once gone,
The world will never look upon.

Vikram Seth
from *The Elephant and the Tragopan*, 1991

Dam critics are often asked what are their alternatives to building large dams. The question begs an easy answer such as small dams, but this would not do justice to the arguments of dam opponents. For many critics oppose both the means *and the ends* of dam builders — they are not interested in alternative methods of providing water for huge irrigation schemes which dispossess small farmers for the benefit of agribusiness, alternative energy sources to feed the wasteful habits of cities and industries, or alternative ways of wiping out floods on which rural people and ecosystems depend.

If the question is turned from 'what are the alternatives to dams?' to 'how can we enable people to obtain adequate and equitable supplies of water and energy far into the future, reduce the destructiveness of floods, and protect our watersheds from degradation?' then it can be properly answered. This chapter describes some of the innumerable technologies, land and water management practices, and forms of social organization which can help satisfy human needs and desires for food and fibre, water, and protection from dangerous floods, while also maintaining healthy rivers. Sustainable energy technologies and practices are discussed in chapter eight.

A defining feature of most of the technologies described below is that they are small scale. Just because a technology is small, however, does not guarantee that it will not have undesired social and environmental consequences — or that it will work. Ian Smillie, former Director of the Canadian volunteer aid agency CUSO, notes that the fashion for appropriate technology among aid donors in the 1970s, 'left the Third World littered with windmills that didn't turn, solar water heaters that wouldn't heat, and biogas experiments that were full of hot air before they started.'[1]

Experience shows that the socio-economic and political context in which technologies and policies are applied is the key to their success or failure, and to which sections of society end up benefiting most from them. It also shows that what works well in one community or country, will not necessarily work elsewhere. If 'appropriate' technologies are to fulfil their potential to meet human needs in an equitable and non-destructive fashion, they should ideally be instigated by the people who are to benefit from them; where they are not, the supposed beneficiaries must understand what the technology is, how it works, and who stands to gain and to lose. Most important, the people in whose name the technology is being installed should willingly accept it and participate in its implementation.

MANAGING THE LAND TO MANAGE THE WATER

> *. . . the belief that the social dilemmas created by the machine can be solved merely by inventing more machines is today a sign of half-baked thinking which verges close to quackery.*
>
> Lewis Mumford
> *Technics and Civilization*, 1934

Any sensible strategy of freshwater management must aim to have healthy rivers which to the greatest extent possible are unpolluted, supportive of a wide diversity of lifeforms, and able to flood according to their natural pattern. Achieving a healthy river requires a healthy watershed: the two cannot be separated. Where watersheds are degraded by deforestation, unsustainable farming practices, and urbanization, then rivers will also be degraded. Maintaining or restoring watersheds with forests, wetlands, and healthy soils minimizes damaging flash floods and the risk of drought, cuts down soil erosion and so the amount of sediments washed into the river bed, increases the ability of the river system to break down and filter pollutants, and provides diverse wildlife habitats.

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[1] Smillie, I. (1991) *Mastering the Machine: Poverty, Aid and Technology*. Intermediate Technology, London. See also Burch, D. (1982) 'Appropriate Technology for the Third World: Why the Will is Lacking', *The Ecologist*, Vol. 12, No. 2 and Adams, W.M. (1992) *Wasting the Rain: Rivers, People and Planning in Africa*. Earthscan, London, 192, 194.

Often when a large dam is advocated as a means of flood control or water storage the best alternative is not a small dam or other technology, but the regeneration of watershed forests. Hydrologically, forests and the soils under them act like a sponge, soaking up rainfall and floods and then gradually releasing the water into the river or allowing it to percolate into aquifers. When the forests are cleared, the speed at which rain falling on a watershed runs into its rivers is greatly increased. In semi-arid areas, where a whole year's rain can fall in just a few intense storms, the deforestation of watersheds can greatly amplify the seasonality of rivers, leading to disastrous floods in the wet season and long droughts in the dry. The most notorious example of this is Cheerapunji in northeast India, one of the world's wettest places, with an average rainfall of more than nine metres. Illegal logging and the expansion of farmland have denuded the once lushly forested slopes of the region, and it now suffers floods for three to four months and severe water shortages for the rest of the year.[2]

The long-term hydrological effect of deforestation depends on what type of land use follows. Some agroforestry systems can more or less replicate the hydrological role of the original forest. Heavy grazing, on the other hand, which prevents vegetation from regenerating and compacts the soil under hooves, will ensure the continuation of high rates of run-off. Urbanization, by covering the land with an impermeable layer of roads and roofs, and funnelling rainwater through sewers and drains, can drastically speed up the rate at which stormwater (polluted with oil, petrol, lead, and other contaminants washed off the streets) enters a river.[3]

It is often assumed that the loss of forests not only leads to greater run-off during storms, but also reduces local or regional rainfall. A hundred years of vegetation and rainfall data from India have indicated a tendency towards fewer days with rain, and less rainfall in total, as local deforestation increases.[4] There is, however, little definitive scientific evidence linking vegetation loss and decreasing rain, although this may mainly be due to the difficulty in distinguishing between the many factors which affect rainfall. A study of the watershed of the Madden Dam, which supplies water for the Panama Canal, indicated that there was little difference in the annual run-off between forested areas and those which had been cleared for farming. There was, however, a marked change in the distribution of run-off from the deforested areas, with higher flood peaks and reduced dry season flows. These hydrological changes have caused dry season water shortages in the canal.[5]

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[2] Rao, R. (1989) 'Water Scarcity Haunts World's Wettest Place', *Ambio*, Vol 18, No. 5, 300; 'Deforestation creates drought in wettest spot of the world', *US Water News*, January 1995.

[3] Goudie, A. (1987) *The Human Impact on the Natural Environment*. Second Edition. MIT Press, Cambridge, MA, 158-162.

[4] Bandyopadhyay, J. (1989) 'Riskful Confusion of Drought and Man-Induced Water Scarcity', *Ambio*, Vol. 18, No. 5., 285.

[5] Simons, P. (1989) 'Nobody loves a canal with no water', *New Scientist*, October 7. For a short discussion of the debate over the link between rainfall and forests see Goudie (1987) op. cit., 259-260. See also Molion, L.C.B. (1989) 'The Amazonian Forests and Climatic Stability', *The Ecologist*, Vol. 19, No. 6.

As well as worsening floods and drought, the degradation of watershed vegetation also boosts soil erosion. Farming and grazing have increased the annual sediment load of the world's rivers from an estimated nine billion tonnes to perhaps as much as 45 billion tonnes. Apart from its consequences for the capacity of reservoirs and irrigation canals, increasing the sediments washed into rivers can worsen flooding by raising the level of the river bed, and can also damage riverine lifeforms in a number of ways. Severe soil erosion also drastically reduces agricultural productivity.[6]

The draining and ploughing of floodplains and riverine wetlands has had a similar effect in hydrological terms to the loss of upland forests. A study by the Illinois State Water Survey found that every one per cent increase in watershed area covered by wetlands decreased flood peaks in streams draining the watershed by nearly four per cent.[7] Marshes and other types of wetlands help keep rivers healthy in other ways, such as by naturally filtering pollutants and excess nutrients from sewage and agricultural run-off, trapping sediments, and by providing habitat for fish and other riverine organisms. An estimated 87 million hectares of wetlands, most of them freshwater marshes, have been destroyed in the US since colonial times. Today less than 100 million hectares of US wetlands remain. Along the lower Mississippi, nearly four-fifths of the floodplain hardwood forests have been lost to agriculture. European floodplain marshes and forests have suffered even worse the depredations of river regulation and channelization, intensive agriculture and urban sprawl. Around 90 per cent of the former floodplain of the Rhine in Germany has been drained and developed.[8]

Protect and Restore

Given the effects of the abuse of watershed ecosystems, part of the answer to the water problems experienced in many areas of the world lies in protecting forests and wetlands where they still exist, and regenerating watersheds which have been degraded. If this is not done then no amount of new dams or other technologies will be able to prevent droughts and floods, and the performance of existing dams will continue to worsen.

Deforestation is propelled by numerous intertwined forces, especially excessive commercial logging, ranching and other forms of agricultural expansion, and development projects like mines, dams, plantations and roads. Curtailing these forces means taking measures such as strict controls on logging, reforming land tenure laws outside forest areas so that access to land is more equitably distributed and there are fewer landless poor

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[6] National Research Council (1993) *Soil and Water Quality: An Agenda for Agriculture*. National Academy Press, Washington, DC, 337. Worldwide, erosion leads to crop production becoming impossible or uneconomic on around 20m ha every year.

[7] Faber, S. (1994) 'Acquisition and Restoration of Flooded Agricultural Land', *River Voices*, Winter.

[8] Maltby, E. (1986) *Waterlogged Wealth: Why Waste the World's Wet Places?* Earthscan, London; Gore, J.A. and Shields, F.D., Jr. (1995) 'Can Large Rivers Be Restored?, *Bioscience*, Vol. 45, No. 3; Dugan, P.J. (1990) *Wetland Conservation: A Review of Current Issues and Required Action*. IUCN, Gland, 33.

forced to clear the forest, and halting government subsidies and support for land clearance and destructive development projects. As well as land reform outside the forests, the granting of secure tenure to indigenous forest peoples, and to harvesters of non-timber forest products such as the rubber-tappers of Brazil, is also vital. People who directly depend on the survival of the forest have historically shown themselves to be its best protectors: communities from the Karen ethnic minority in Thailand, for example, strictly conserve forests which they know to be a source of water for their rice paddies.[9]

Many traditional agricultural methods have been developed which help reduce the negative hydrological consequences of farming watersheds, including the terracing of steep hillsides, and agroforestry and other forms of multiple cropping which minimize the area of soil directly exposed to rainfall. Modern agricultural researchers are also finding methods, many copied from traditional techniques, of growing crops which minimise run-off and erosion. One of the key techniques of organic agriculture — building up soil organic matter by adding compost and manures — greatly increases the ability of the soil to retain moisture, with a proportionate reduction in the amount of water which runs off.[10]

The protection of floodplain wetlands depends on halting the construction of dams and other river engineering projects and overturning agricultural and urban development policies which promote wetland draining and paving. In places, protecting the rights of traditional wetland farmers, fishers, hunters and gatherers, herders and ranchers, will also protect the wetlands. Education about the ecological importance of wetlands, and the recognition of their recreational value will also help to halt their destruction.[11]

FLOOD MANAGEMENT

> *Rivers [said 6th century BC Taoist engineer Chia Jang] were like the mouths of infants — if one tried to stop them up they only yelled the louder or were suffocated.*
>
> Joseph Needham
> *Science and Civilization in China*, 1971

Bangladesh consists largely of the huge floodplain where three of the world's largest rivers, the Meghna, Brahmaputra and Ganges, intermingle and fan out to meet the sea.

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[9] Boonkrob, P. (1995) 'Community Protection of a Watershed', *Watershed*, Bangkok, Vol. 1, No. 1, July. See also articles in 'Save the Forests: Save the Planet. A Plan for Action', special issue of *The Ecologist*, Vol. 17, No. 4/5, 1987; and 'Amazonia: The Future in the Balance', special issue of *The Ecologist*, Vol. 19, No. 6, 1989; also see Colchester, M. and Lohmann, L. (1992) *The Struggle for Land and the Fate of the Forests*. Zed Books, London.

[10] See e.g. Laflen, J.M., et al. (1990) 'Soil Erosion and a Sustainable Agriculture', in Edwards, C.A. et al. (eds.) *Sustainable Agricultural Systems*. SWCS, Ankeny, Iowa, 353; National Research Council (1993) op. cit., 355).

[11] The value of Canadian wetland recreation — hunting, fishing, bird watching, tourism, sailing, swimming, etc. — is estimated to have exceeded US$3.9 bn in 1981 (Dugan (1990) op. cit.).

The Bangladeshis' language reflects their history of living and dying with floods. Bengali distinguishes between abnormally severe floods, termed *bonna*, and the more frequent rainy season floods, or *barsha*, which Bangladeshi villagers do not consider a threat 'but rather a necessity for survival'.[12] Around the world, the failure of conventional flood control measures is creating political space for those who believe that flood damage can best be reduced by managing floods rather than trying to halt them. In essence, by adapting to *barsha* and minimising the probability and destructiveness of *bonna*, instead of vainly trying to stop all floods.

The debate between flood 'controllers' and 'managers' is an ancient one, harkening back to arguments between Confucian 'contractionists' and Taoist 'expansionists' over whether China's unruly rivers should be constricted between high embankments, or allowed to spread out over their natural floodplain.[13] In the US, the debate dates back at least to the 1850s, when Congress was advised that large areas of the Mississippi floodplain should be used as flood storage and overflow areas. These expansionist views were passed over, however, in favour of those of the Army Corps of Engineers, who recommended embanking the Mississippi in a single channel isolated from its floodplain. This 'structural' approach was dominant for more than a century throughout the US but in recent decades has been losing scientific and public credibility.

Today, floodplain management involving non-structural methods is strongly in the ascendant. In 1993, massive flooding along the Missouri and Upper Mississippi - two of the most dammed and embanked rivers in the world - took at least 38 lives, and caused damage costing an estimated $12-$16 billion. James Durkay, the Corps of Engineers' assistant director of civil works, told the journal *Civil Engineering* in January 1994 that after the 'Great Flood of 1993', 'it's unlikely you'll see more reservoirs or more levees' on the biggest river system in the US.[14]

The principle of floodplain management is to allow some land to flood so that other land can stay dry — letting floodplain wetlands play their natural role of providing flood storage while strengthening the protection for buildings at risk from exceptional floods. Flood management requires regulations which discourage new floodplain development, financial incentives for people living in the riskiest areas to move to higher ground, improved flood warning systems, strengthened embankments around urban areas, floodproofing of farm buildings and other isolated structures by elevating them or building ring-dykes around them, and allowing the most threatened floodplain farmland to revert to wetland. Several entire small towns in the Mississippi Basin decided to move to higher

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[12] Boyce, J.K. (1990) 'Birth of a Megaproject: Political Economy of Flood Control in Bangladesh', *Environmental Management*, Vol. 14, No. 4.

[13] Needham, J. (1971) *Science and Civilization in China.* Vol. 4. Part III. Cambridge University Press, 235.

[14] Interagency Floodplain Management Review Committee (1994) *A Blueprint for Change. Sharing the Challenge: Floodplain Management into the 21st Century*. Report of the IFMRC to the Administration Floodplain Management Task Force, Washington, DC, June; Denning, J. (1994) 'When the Levee Breaks', *Civil Engineering*, January.

ground after the 1993 flood, and hundreds more are considering moving at least some of their buildings. Thousands of hectares of the most flood-prone farmland in the basin are being bought up by conservationists and government agencies to be turned into wetland wildlife refuges.[15]

A similar change in attitudes to rivers and floods is underway in Europe. 'We've paved over too many meadows and straightened too many rivers', Josef Leinen, environment minister for the German state of Saarland, told reporters after the severe flooding on the Rhine in early 1994. A decade before, a Franco-German agreement was signed to renew wetlands along the Rhine and so help both reduce flood damage downstream and restore some of the floodplain ecosystem. The plan has moved slowly, mainly due to the cost of buying out landowners, but by 1995, two spill-over areas had been created on the German side of the Rhine.[16]

The main justification for the planned 75 metre-high Serre de la Fare Dam on France's upper Loire was that it would prevent the recurrence of floods which killed eight people in a village near the town of Le Puy in 1980. As an integral part of their campaign against Serre de la Fare, the Le Puy-based activist group SOS Loire Vivante worked with hydrologists and engineers to devise an alternative flood control strategy which would not entail the destruction of part of one of Europe's most beautiful stretches of river. SOS Loire Vivante's strategy is based on five elements: improving the flood warning system; strict enforcement of regulations against construction in areas most at risk; improved protection for the most threatened buildings; minor works to clear the river bed and banks of obstacles to the free flow of water; and creating a committee of local residents, elected officials, NGOs, and businesses to oversee the implementation of the plan. When the government confirmed in January 1994 that it would not build Serre de la Fare, SOS Loire Vivante's flood management strategy was adopted by the local authorities.[17]

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[15] Williams, P.B. (1994) 'Flood Control vs. Flood Management', *Civil Engineering*, May; Faber (1994) op. cit.

[16] 'Germans rethink river management after recent floods', *US Water News*, March 1994; Simonian, H. (1995) 'Floods of tears on the Rhine', *Financial Times*, 8 February, 1995.

[17] 'SOS Loire Vivante: Actions and Strategies', SOS Loire Vivante, Le Puy, May, 1995; *SOS Loire Vivante Infos*, No. 24, March, 1995.