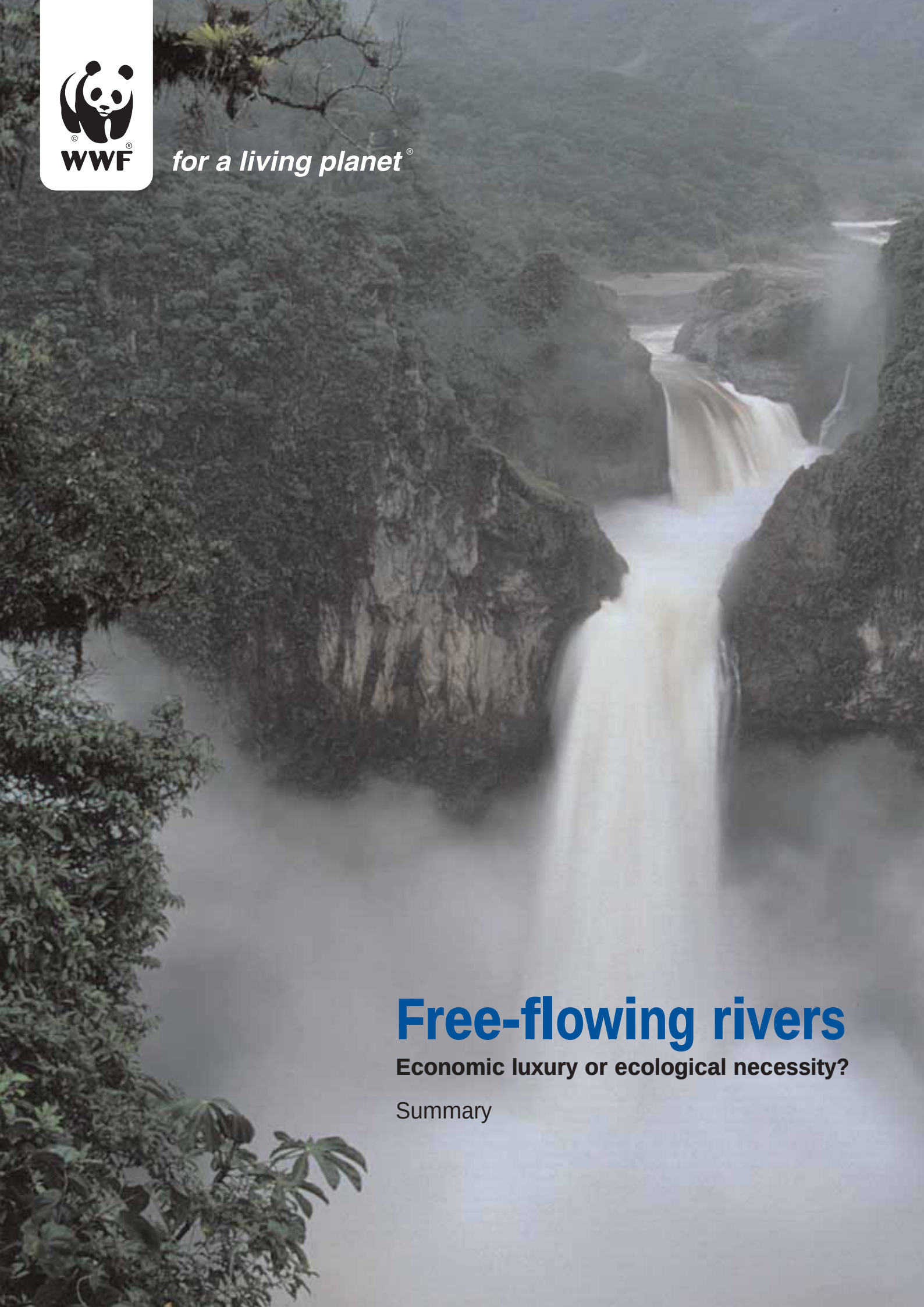

WWF

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# Free-flowing rivers

## Economic luxury or ecological necessity?

Summary

## Free-flowing rivers – Economic luxury or ecological necessity?

### Contents



**Wild rivers are earth's renegades, defying gravity, dancing to their own tunes, resisting the authority of humans, always chipping away, and eventually always winning.**

*Richard Bangs, River Gods*

# Introduction

The history of human civilisation is inextricably linked to the world's rivers. Many of the world's ancient societies developed alongside major rivers. But the importance of rivers for human development has brought with it pollution, degradation and overexploitation. Rivers have been diverted for agricultural irrigation, straightened to facilitate navigation and dammed for hydropower. The growing world population and changes in lifestyle have put more and more demands on rivers and their watersheds, today leaving very few systems in a natural state.

The report "Free-flowing rivers – Economic luxury or ecological necessity" assesses the state of the world's remaining free-flowing rivers and seeks to answer the question why we should maintain our last free-flowing rivers and whether this is a luxury or a necessity. It shows that few rivers remain free-flowing and a concerted effort for their conservation is urgently needed. WWF calls on governments to identify those free-flowing rivers that are ecologically important and that provide important services to people and to safeguard these rivers from being developed. WWF calls for the immediate protection of a number of rivers, including the Amur, the Salween, the Chishuihe and the Amazon.

Clockwise from top left: © WWF-Canon/André BÄRTSCHI; © WWF-Canon/John RATCLIFFE; © WWF-Canon/Michel GUNTHER; © WWF-Canon / Edward PARKER

## What is a free-flowing river?

WWF defines a free-flowing river as any river that flows undisturbed from its source to its mouth, at either the coast, an inland sea or at the confluence with a larger river, without encountering any dams, weirs or barrages and without being hemmed in by dykes or levees. In today's world such rivers, particularly those that run over long distances, are increasingly rare. In large river systems distinct stretches of rivers can retain characteristics of a free-flowing river, despite the presence of water infrastructure upstream or downstream of this stretch.

Rivers have formed over a long time and continue to evolve because of their dynamic nature. Human activities accelerate and redirect these processes of change in many different ways, indirectly through anthropogenic stressors such as global warming or directly by interfering in the physical, geo-morphological characteristics of a river. Two key influences on river flow from source to mouth are:

a) flow modification structures, such as dams, weirs and barrages, for hydropower production, water supply and irrigation and flood control

b) channel modification: the dredging and straightening of rivers for navigation purposes.

These modifications affect one or more of the spatial dimensions of rivers. Flow modification structures interrupt the longitudinal connectivity of rivers as well as affect groundwater tables or seasonal flooding patterns (lateral dimension). Channel modification can affect flooding patterns as well as the variations in river depths. This report considers whole rivers, from source to mouth, with as key parameter the absence of large dams[1] over the entire length of the river from source to either the river mouth or confluence with a larger river.

**1 & 2** A free-flowing river is a river that flows undisturbed from its source to its mouth, at either the confluence with a larger river, inland sea or at the coast.

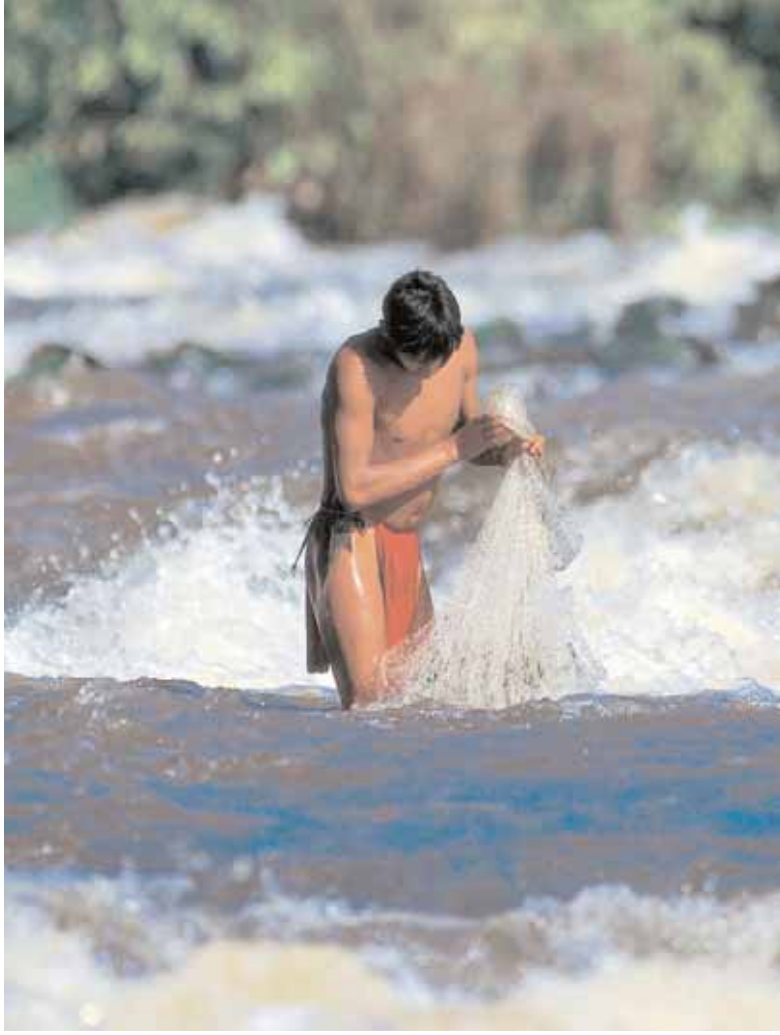
**3** An example of channel modification – a canalised section of the São João River in Brazil

**4** The Petit Saut Dam in French Guiana not only interrupts the flow of the river but is flooding 300 square km of forests.

[1] The International Commission on Large Dams (ICOLD) defines a large dam as 15 metres or higher. Dams between 5 and 15 metres with a reservoir volume of more than 3 million cubic metres are also classified as large dams.

## The functions of free-flowing rivers and the impacts of damming them up

Although freshwater ecosystems occupy less than one per cent of the world's surface, they make some of the largest contributions of all ecosystems to human welfare. Freshwater is necessary for drinking, hygiene and agriculture, whilst fish and fishery products are particularly important in developing countries. Many of these provisioning services can be maintained to some extent in modified rivers, and people often rely on dams to provide that service. The key benefit derived from free-flowing rivers over dammed rivers is food supply. Dams alter river ecosystems and in many cases will impact negatively on the fish species native to the river. This directly affects fisheries productivity both upstream and downstream of the dam. Floodplains are important feeding and spawning ground for fish, but by replacing seasonal flow patterns with a year round steady outflow, floodplains can no longer perform this function. Examples of a decline in the fisheries production of native species around the world are numerous and the impacts on migratory species in particular can be devastating.



The provisioning services of rivers for water, food and energy, have long been acknowledged, but recognition of other, equally important, services has grown. Regulating services of freshwater systems include water purification, flood mitigation and sediment deposition and free-flowing rivers play an important part in the global water cycle. Rivers contribute to pollution control by transport and removal of pollutants and excess nutrients. This capacity is reduced because of dams, as pollutants get trapped behind dams through accumulation of sediment and this can pose a hazard when the lifespan of a dam comes to an end. Furthermore, rivers also play an important role in the transport of sediment, as illustrated by the events in New Orleans following hurricane Katrina in 2005. Coastal wetlands, marshes and islands used to provide protection from storm surges, but since the 1930s the wetlands have been steadily eroded by the sea. A major contributing factor to this erosion was the extensive modification of the Missouri and upper Mississippi watershed, with sediments trapped by large dams and the extensive levee systems on the lower Mississippi channelling remaining sediments too far into the Gulf of Mexico to replenish the delta's coast.

Free-flowing rivers also have a cultural importance. They provide aesthetic values, literary imagery and are important religiously and spiritually. Many tribal people have close relationships with rivers. The Maori in New Zealand for example attribute losses in the healing power of a river to the construction of dams upstream. Free-flowing rivers provide important recreational services, varying from salmon fishing to white water rafting, and are valuable for educational purposes.

Finally, the supporting services provided by rivers and streams are crucial as they provide the basis for all other benefits gained from the river. It is these services, particularly biodiversity and habitat provision, which are often most affected by dams and water infrastructure, but the effects of their loss on people are not immediately apparent. River modification affects the pattern of flows and particularly reduces the occurrence of large floods in rivers subject to strong wet and dry season patterns, whereas it is the natural variability in water flows that sustains freshwater flora and fauna. The impacts of these modifications are far reaching as fish life cycles and sediment and nutrient transport functions are disturbed.

Left to right: © WWF-Canon / Roger LE GUEN; © WWF-Canon/Stéphane MAURIS; © WWF-Canon / Roger LE GUEN

**1** Free-flowing rivers support fisheries that are vital to the survival of many of the worlds' poorest people.

**2** Maori culture is closely linked to free-flowing rivers

**3** free-flowing rivers carry the sediments needed to sustain coastal estuaries and mangroves.

The degree to which river modification disrupts the services provided by free-flowing rivers depends to some extent on the siting of the dam. There are no hard rules about what ecologically constitutes the least damaging site for a dam and the level of damage depends on the presence of other dams in the basin. In general dams with the least impacts are those that: cause the least interruption to natural river flows; keep a river's main stem free-flowing; inundate the smallest possible area; and are sited on tributaries in the headwaters that control only a small part of the inflows into the river's main stem.

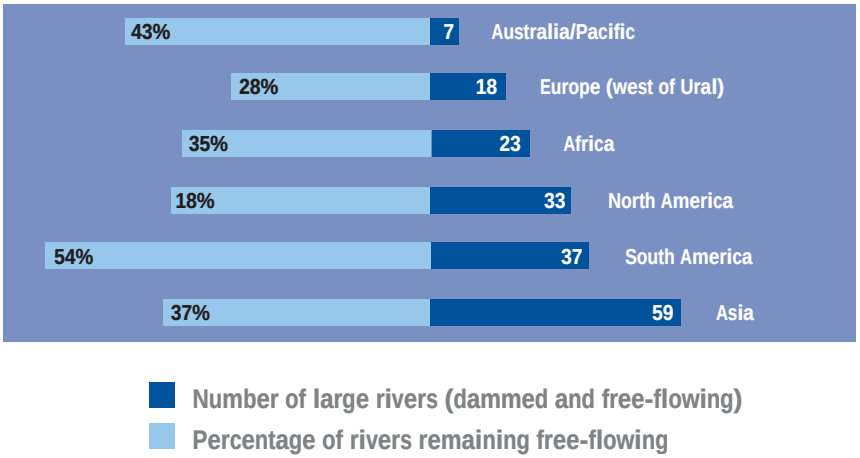
Several sources, including the Millennium Ecosystem Assessment and the WWF Living Planet Report, suggest that freshwater biodiversity is being lost at a faster rate than any other ecosystem. Globally there is agreement that these developments are of concern and there are a number of global commitments specifically targeted at reducing the loss of biodiversity. The Convention on Biological Diversity (CBD) is one of the key fora. Parties have committed to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth. This target was adopted by the 2002 World Summit on Sustainable Development.

## The state of the world's longest rivers

Most people in the world live within reach of a river, stream or creek but there is a lack of data on the exact number of rivers worldwide. This report presents an analysis of river fragmentation on a global scale, based on individual rivers with a length of more than 1,000 kilometres. Data on river fragmentation was obtained by cross referencing 177 rivers longer than 1,000 km against the ICOLD World Register of Dams. Where a river was found to have one or more dams on the main stem it was classified as fragmented.

The analysis shows that globally out of 177 rivers longer than 1,000 km, only 64 rivers (less than 40 per cent) are still free-flowing. Figure 1 shows the regional distribution of all large rivers (whether dammed or free-flowing) and the regional distribution of large free-flowing rivers, as a percentage of all rivers over 1,000 km long.

## Figure 1: Regional distribution of rivers longer than 1,000 km and percentage of rivers remaining free-flowing




The figure shows that most large rivers are found in Asia, followed by South and North America. Australia/Pacific has the fewest large rivers with three out of seven, the Cooper Creek, Sepik and Fly rivers, remaining free-flowing.

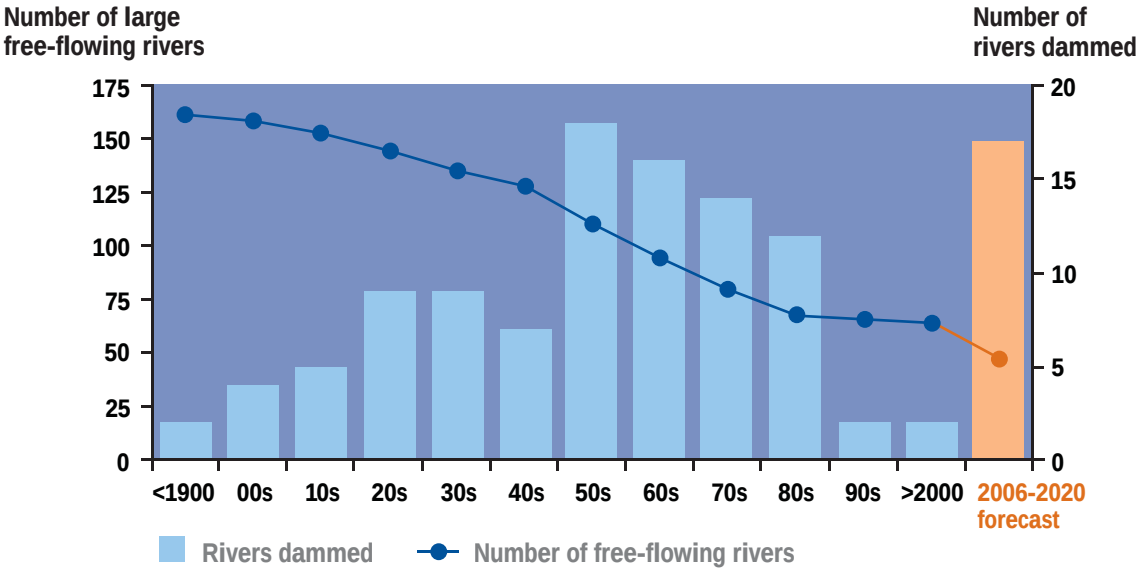
Europe, including areas west of the Ural, has relatively few large rivers and has modified almost all of them. Rivers such as the Danube, Volga, Rhine and Tagus have been extensively dammed and modified. Only one of Europe's large rivers, the Pechora, remains free-flowing from source to sea, running for 1809 km from the Ural Mountains to the Barents Sea. The Vychegda is an 1130 km tributary of the Northern Dvina in north-western Russia and three tributaries of the Volga also remain free-flowing.

Asia and South America harbour both the highest number of large rivers and the highest number of large free-flowing rivers. In Asia nearly 40 per cent of large rivers remain free-flowing, mostly located in the north. In South America just over half of the continent's 37 large rivers remain free-flowing. Most of the remaining free-flowing rivers are large tributaries of the world's major river systems. Rivers within the Amazon system alone account for 20 per cent of free-flowing rivers over 1,000 km. Tributaries in the Lena, Yenisei and Amur river systems in the far east of Russia account for another 20 per cent of free-flowing rivers.

Of particular concern is the loss of long distance connectivity between the sea and inland rivers. Only 21 rivers longer than 1,000 km that drain directly into the sea remain undammed (Map 1). Ecologically, fragmentation is a problem as maintaining connectivity on all levels is essential to conserve freshwater biodiversity, although the importance of connections between a rivers' source and the sea over long distances is not yet fully understood. The importance of these links for migrating fish species are well known, but the underlying mechanisms of these relations and the distances over which this connectivity is important are a topic for which scientific research is urgently needed.

An analysis of the rate at which large free-flowing rivers have been lost shows that the decline started in the first half of the 20th century (Figure 2). By 1950 20 per cent of the world's large rivers had been dammed, more than half of these in North America. The rate of damming increased rapidly in the 1950s in which decade 18 more free-flowing rivers were dammed for the first time, dominated by dam construction in Europe and Asia. The sixties and seventies saw equally large losses of free-flowing rivers, many of which were in Asia but increasingly free-flowing rivers were also lost in South America. The eighties were the last decade with high losses of free-flowing rivers. Twelve large rivers were dammed for the first time, four of which are in Africa. By 1990 only 68 large rivers were left free-flowing.

## Figure 2: Rates of damming of free flowing rivers



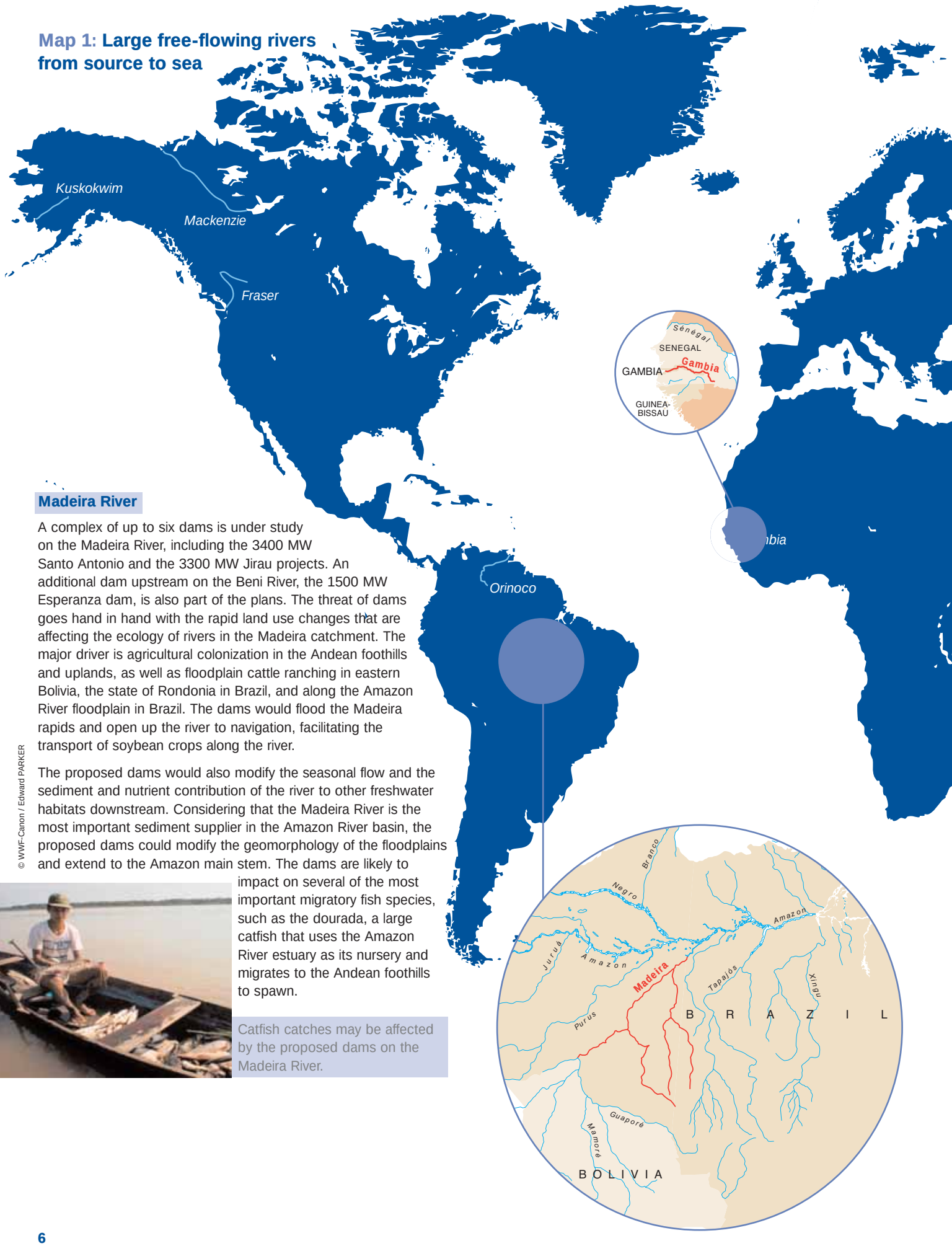

As dam construction slowed at the end of the 20th century, the rate at which large free-flowing are being lost has stabilized, with only four more free-flowing rivers dammed since 1991. But today the demand for dams, either for hydropower or water supply, is on the rise – driven by growing populations and growing demands for water, food and energy, together with the increasing threat of climate change. Many of these rivers face acute threats of being dammed in the near future and WWF estimates that of the world's remaining 64 large free-flowing rivers at least 17 large free-flowing rivers are in danger of being dammed by 2020. This does not include any of the large tributaries of the large Siberian river systems, many of which have a high hydropower potential and could be dammed up in the future. Proposals also exist to divert water from some Siberian rivers to water stressed river basins in the south, including the shrinking Aral Sea.

In Africa, on the Gambia River plans are afoot for the Sambangalou Dam, whilst on the Rufiji River Stiegler's Gorge has been identified as a potential site for a 1400 MW hydropower development. In South America, both the Amazon and Orinoco basins are subject to plans for hydropower development, although at present these appear more concentrated on large tributaries rather than on the main stem.

Many of the remaining undammed large rivers are situated in remote areas of the Russian Federation. Until now, the hydropower potential of these rivers has seen little development, but hydropower development initially in the Far East and the Caucasus, followed by the large Siberian rivers has been recognized by the government as a priority. The growing demand for energy in China is also likely to be an incentive for hydropower development on these rivers. The Aldan River, a major tributary of the Lena, has been identified as having significant hydropower potential. The creation of a South Yakutia hydro complex would contribute to the Far Eastern grid and enable export to Asia and the Pacific. However, the unfavourable economic situation in the region means that in the near future most rivers are likely to remain free-flowing, although these freshwater systems face many other environmental threats, including pollution from heavy industry.

Asia (excluding Russia) has four large undammed rivers remaining that run from source to sea, most notably the Brahmaputra and Salween rivers Both have their source on the Tibetan plateau and run respectively through China, India & Bangladesh and China, Myanmar & Thailand. The Brahmaputra basin is likely to see heavy development of hydropower on tributaries in India and Bhutan in the near future, though development on the main stem is at present unlikely. The Salween however, is under serious threat of fragmentation on the main stem, with plans for cascades of dams on both the Upper Salween (Nujiang) in China and the lower reaches in Myanmar.

## Map 1: Large free-flowing rivers from source to sea



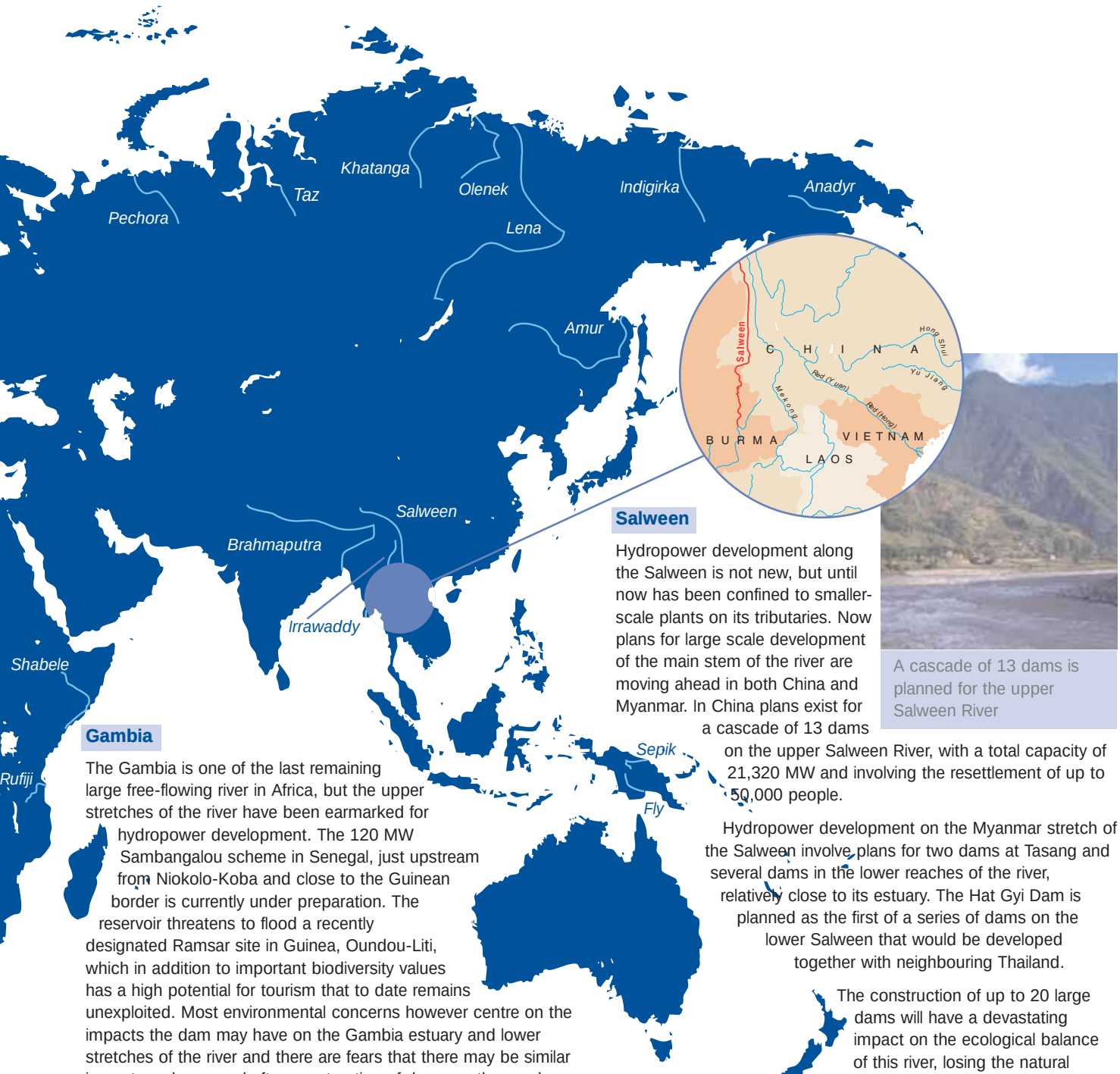

### Madeira River

A complex of up to six dams is under study on the Madeira River, including the 3400 MW Santo Antonio and the 3300 MW Jirau projects. An additional dam upstream on the Beni River, the 1500 MW Esperanza dam, is also part of the plans. The threat of dams goes hand in hand with the rapid land use changes that are affecting the ecology of rivers in the Madeira catchment. The major driver is agricultural colonization in the Andean foothills and uplands, as well as floodplain cattle ranching in eastern Bolivia, the state of Rondonia in Brazil, and along the Amazon River floodplain in Brazil. The dams would flood the Madeira rapids and open up the river to navigation, facilitating the transport of soybean crops along the river.

The proposed dams would also modify the seasonal flow and the sediment and nutrient contribution of the river to other freshwater habitats downstream. Considering that the Madeira River is the most important sediment supplier in the Amazon River basin, the proposed dams could modify the geomorphology of the floodplains and extend to the Amazon main stem. The dams are likely to impact on several of the most important migratory fish species, such as the dourada, a large catfish that uses the Amazon River estuary as its nursery and migrates to the Andean foothills to spawn.



Catfish catches may be affected by the proposed dams on the Madeira River.




## Salween

Hydropower development along the Salween is not new, but until now has been confined to smaller-scale plants on its tributaries. Now plans for large scale development of the main stem of the river are moving ahead in both China and Myanmar. In China plans exist for a cascade of 13 dams on the upper Salween River, with a total capacity of 21,320 MW and involving the resettlement of up to 50,000 people.



A cascade of 13 dams is planned for the upper Salween River

© P Schelle / WWF International

Hydropower development on the Myanmar stretch of the Salween involve plans for two dams at Tasang and several dams in the lower reaches of the river, relatively close to its estuary. The Hat Gyi Dam is planned as the first of a series of dams on the lower Salween that would be developed together with neighbouring Thailand.

The construction of up to 20 large dams will have a devastating impact on the ecological balance of this river, losing the natural connection between Tibetan plateau, South West China and Andaman Sea. The upper reaches of the Salween, known as the Nujiang in China, are just being discovered as a site for white water rafting and there is good potential for other forms of ecotourism in the region, including nature tours, cycling and trekking. Whilst it is unlikely that these kinds of industries will bring in similar amounts of money as the dams, combined with sensitive development of the hydropower potential of the Nu tributaries it could offer a sustainable alternative.

## Gambia

The Gambia is one of the last remaining large free-flowing river in Africa, but the upper stretches of the river have been earmarked for hydropower development. The 120 MW Sambangalou scheme in Senegal, just upstream from Niokolo-Koba and close to the Guinean border is currently under preparation. The reservoir threatens to flood a recently designated Ramsar site in Guinea, Oundou-Liti, which in addition to important biodiversity values has a high potential for tourism that to date remains unexploited. Most environmental concerns however centre on the impacts the dam may have on the Gambia estuary and lower stretches of the river and there are fears that there may be similar impacts as happened after construction of dams on the nearby Senegal River, which resulted in degradation of the floodplain ecosystems and increases in water borne diseases.

Fisheries off the coasts of Gambia and Senegal are linked to the inflow of freshwater from the Gambia and Senegal rivers.

© WWF-Canon / Olivier VAN BOGAERT

## Protecting free-flowing rivers

The value of free-flowing rivers has increasingly been recognized and a number of protection mechanisms have been applied in different countries. In the United States and Canada whole rivers can be protected under the 'Wild and Scenic Rivers Act' and the 'Canadian Heritage River System' respectively. Both systems also allow protection of stretches of a river where it maintains a free-flowing character. So for example in the US, a 53 mile section of the Rio Grande – a river that is heavily modified and sometimes even fails to reach the sea – was designated as a wild river area when the Act was passed.

Australia has similar legislation in a number of states, including the Victoria Heritage Rivers Act 1992 which identifies 18 Heritage River Areas which have significant recreation, nature conservation, scenic or cultural heritage attributes. A different type of protection mechanism is in place on the Paroo River in Queensland and New South Wales, which supports extensive wetlands all along its length. The river is protected under the Paroo River Agreement, a non-legislative agreement between the two state governments signed in July 2003, which has a heavy focus on conserving the ecological and cultural values of the river.

The number of specific conservation mechanisms aimed at whole rivers is limited, and many rivers or parts of rivers are protected under other conservation mechanisms. Protected areas are considered to be the most effective way of preserving biological diversity and most countries in the world have established or planned a national system of protected areas. Internationally, under the Convention on Biological Diversity (CBD) all governments are committed to establishing and effectively managing representative protected areas systems, including for inland waters, by 2010. The CBD suggests that parties take urgent action to address the under-representation of marine and inland water ecosystems in existing national and regional systems of protected areas.

There is also the 1972 World Heritage Convention which links the protection of cultural and natural heritage. Experience with protection for free-flowing rivers through designation as a World Heritage Site is mixed. In 1983, World Heritage status was an important tool in protecting the Franklin River in Tasmania from damming. However, currently the World Heritage status of the Three Parallel Rivers in China appears to offer the Salween little protection from development.

One international treaty with a strong freshwater focus is the Ramsar Convention on Wetlands. Signed in 1971 this intergovernmental treaty provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Ramsar Convention does not automatically protect wetlands from the impacts of dam projects, but the requirement to maintain a certain 'ecological character' of Ramsar sites, and for the 'wise use' of all wetlands, including rivers, places an obligation on governments to minimize the impacts of river modification on all wetlands.

Left to right: © WWF-Canon / Edward PARKER; © WWF-Canon/Soh Koon CHNG; © WWF-Canon / Elizabeth KEMF

**1** Franklin-Gordon Wild Rivers National Park in Tasmania. World Heritage status helped to protect the Franklin River from being dammed.

**2** Dams can bring substantial benefits, including hydro-electricity, water supply and irrigation.

**3** WWF is working to identify tributaries of the Mekong River that should be awarded protection from dam development.

## River protection vs. River development

As shown above, measures are available to protect free-flowing rivers, but it is telling that measures awarding protection to whole rivers are currently limited to developed countries, where water resources have often already been over-exploited. Most remaining free-flowing rivers are found in developing countries, where there remain some tough choices to be made regarding river protection and river development. The reality is that many rivers in the developing world will continue to be modified to provide water, food and energy where it is desperately needed.

In WWF's view a different approach to free-flowing rivers is needed in developing countries, aimed at balancing the need for developing rivers for energy and water supply and the importance of preserving free-flowing rivers for biodiversity and livelihoods.

The first step in such an approach should be the identification of remaining free-flowing rivers within a country or river basin. An analysis of the biodiversity and conservation values of these rivers, as well as an assessment of the services provided by these rivers to people can then be done to identify priority free-flowing rivers for conservation. These rivers should then be earmarked as 'no-go' rivers for hydropower development, large scale irrigation or channelisation. It is important that this process also involves major stretches of rivers that have already been dammed, but that still retain valuable characteristics of a free-flowing river.

Development of water infrastructure on non-priority rivers could then be considered in accordance with the strategic priorities of the World Commission on Dams. This would involve a comprehensive needs & options assessment, an evaluation of the cumulative impacts of dams within the same basin and the implementation of adequate environmental mitigation measures.

WWF is pioneering this approach in the Mekong River basin where we have identified large scale infrastructure, and particularly hydropower dams, as the single major threat to the aquatic biodiversity of the basin. WWF is engaging with key partners, such as the Mekong River Commission and Asian Development Bank, to promote a strategic, basin-wide approach to hydropower planning. One aim is to identify particularly sensitive tributaries for protection and persuade governments to prioritise dam options in less environmentally sensitive places.

## Conclusions

The importance of rivers for people is irrefutable, supplying such resources as irrigation, industrial and household water and fish, waterfowl, and mussels as important sources of food. Regulating services of freshwater systems include, amongst many others, water purification, flood mitigation and sediment deposition. Finally, freshwater systems offer numerous cultural services, varying from recreational opportunities to aesthetic and spiritual values.

Throughout history people have sought to optimize the benefits provided by rivers, and dams and other river infrastructure have played an important role in this. But with advancing technology the exploitation of rivers has grown to such a scale that the capacity of rivers to provide many important services to people is seriously degraded. Today the majority of river systems have been fragmented and the plight of long rivers in particular is dire. Worldwide only 21 rivers longer than 1,000 km remain that retain a direct connection from source to sea.

With such pressure to utilize rivers for the benefit of people, and if dammed rivers give us energy, water and food, why should we retain free-flowing rivers? WWF believes that free-flowing rivers should be protected for the following reasons:

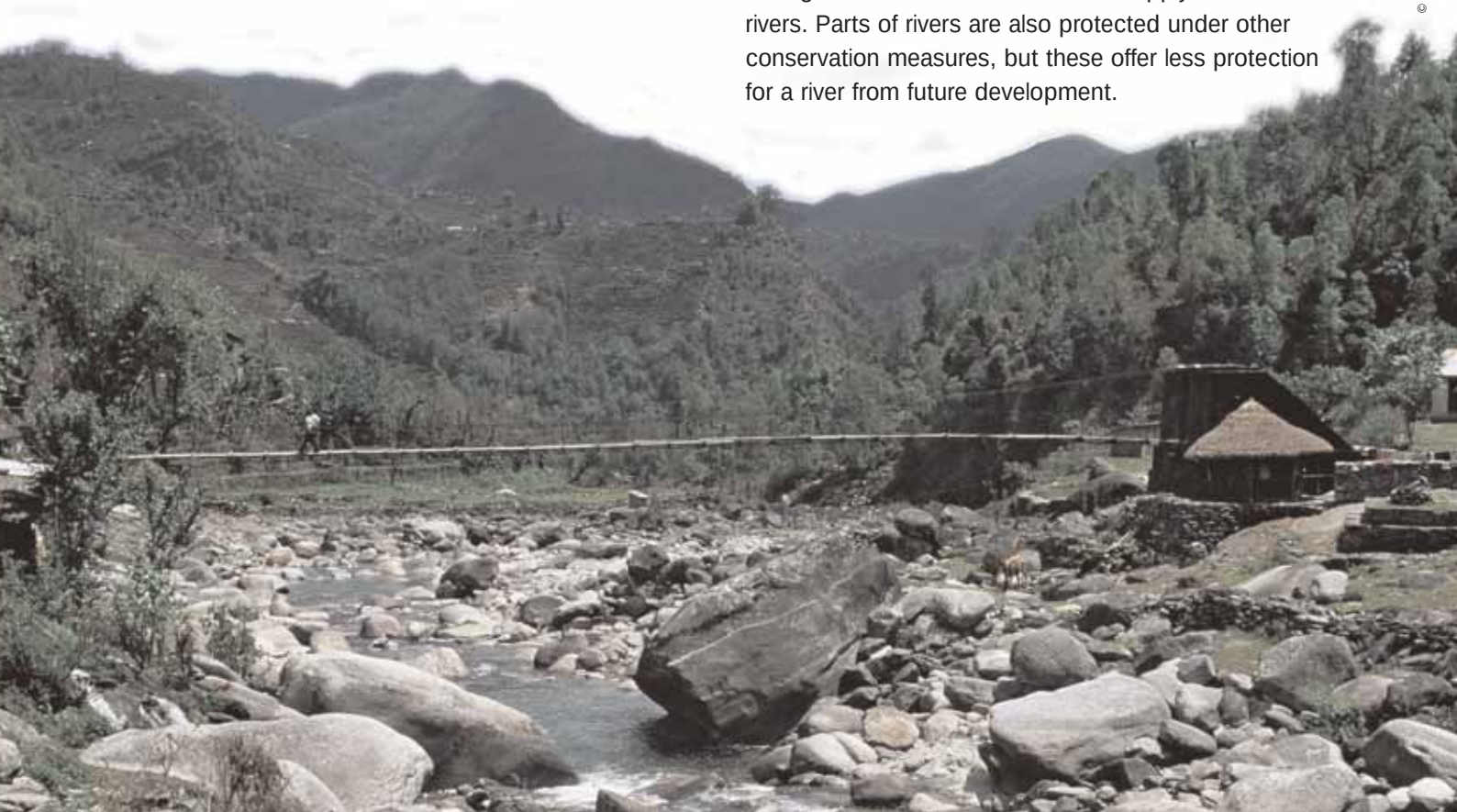
- free-flowing rivers provide important services such as sediment and pollution control, the costs of which when lost do not show up on the balance sheet.

- In recognition of the intrinsic value of biodiversity, freshwater ecosystems and rivers. The importance of conserving freshwater biodiversity for people and nature has been internationally recognized in several fora, including the Convention on Biological Diversity (1992) and the Ramsar Convention (1971). Free-flowing rivers are especially important for the conservation of freshwater fish and floodplain forests.

- For scientific reasons, free-flowing rivers should be protected to increase our understanding of the mechanisms of free-flowing rivers over long distances and the contributions made by these rivers to the global ecosystem. With so few major free-flowing rivers now left, we are on the brink of losing another natural phenomenon without fully understanding the costs of these losses.

- The importance of free-flowing rivers to other biomes, particularly to estuaries. The water conditions in river deltas and marine coastal zones are dependent on rivers and dams higher up in the watershed can significantly damage coastal fisheries.

As this report shows free-flowing rivers have substantial conservation, as well as economic value in the world today, and this is being recognized in many countries through conservation measures that apply to whole rivers. Parts of rivers are also protected under other conservation measures, but these offer less protection for a river from future development.



## Recommendations

WWF recognizes that development of free-flowing rivers is driven by peoples' needs for water supplies and electricity and as such it accepts that some rivers that are now still free-flowing will be dammed in the future. However, the evidence of the importance of free-flowing rivers is so overwhelming, that a concerted effort is now required to permanently protect a great many of the world's remaining free-flowing rivers.

For these reasons, WWF recommends that:

- Governments, as part of their commitments to significantly reducing the rate of loss of biological diversity by 2010, should designate free-flowing rivers that are of high ecological importance or that are representative of certain types of rivers as 'conservation rivers' that should remain free from river modification. Governments should adopt laws and programmes to conserve these rivers effectively.

- Countries who share rivers establish common river basin conservation and management mechanisms, including conservation of remaining free-flowing rivers.

- In each river basin, one or more tributaries should be protected as free-flowing to conserve fauna and flora and the ecological processes they depend on. Ideally dams should not be constructed on the main stems of rivers so as to maintain ecological processes from the source to the sea. Wherever possible such tributaries should link to free-flowing main stems to form an unbroken link from source to sea.

- Development of new water infrastructure should follow the recommendations of the World Commission on Dams.

Based on the case studies in this report, WWF calls for the immediate protection of the following rivers:

- The Chishuihe tributary of the Yangtze River in China should be protected as a free-flowing river to ensure the survival of species endemic to the Yangtze basin that are affected by the Three Gorges and other large dam developments;

- The Salween in China and Myanmar is a unique river linking the Tibetan plateau to the Andaman Sea over a distance of nearly 3,000 kilometres. Its twin rivers, the Yangtze and Mekong, that follow a similar course in the upper watershed have already been dammed;

- The Mara River in Kenya and Tanzania, where the maintenance of adequate flows is crucial to sustaining wildebeest populations in the Masai Mara and Serengeti National Parks;

- The Amur River main stem and appropriate tributaries in China and Russia;

- The main stem and major tributaries of the Amazon River, including the Purus, Xingu and Madeira

Rivers have been dammed too often without consideration of the values and services that are lost. It is now time to take stock of the free-flowing rivers and take protective action to ensure that in twenty years time the world still has free-flowing rivers. In the words of Hal Borland, the American journalist and nature writer:

**"Any river is really the summation of the whole valley. To think of it as nothing but water is to ignore the greater part."**

## Appendix 1:
## Overview of remaining free-flowing rivers

| River (river basin) | Length (km) | Threat of modification |
|---|---|---|
| **Africa** | | |
| **Kasai** (Congo) | 2153 | yes |
| **Lomami** (Congo) | 1500 | n/a |
| **Aruwimi** (Congo) | 1300 | n/a |
| **Okavango** | 1800 | yes |
| **Chari** | 1400 | n/a |
| **Rufiji** | 1400 | yes |
| **Gambia** | 1200 | yes |
| **Shabele** | 1130 | n/a |
| **Asia** | | |
| **Amur** | 2820 | yes |
| **Argun** (Amur) | 1620 | yes |
| **Brahmaputra** | 2896 | yes |
| **Lena** | 4410 | n/a |
| **Aldan** (Lena) | 2273 | Yes |
| **Vitim** (Lena) | 1978 | n/a |
| **Olekma** (Lena) | 1320 | n/a |
| **Maya** (Lena) | 1053 | n/a |
| **Amga** (AIdan) | 1462 | n/a |
| **Ishim** (Ob-Irtysh) | 2450 | n/a |
| **Chulym** (Ob-Irtysh) | 1799 | n/a |
| **Lower Tunguska** (Yenisei) | 2989 | n/a |
| **Stony Tunguska** (Yenisei) | 1865 | n/a |
| **Selenga** (Yenisei) | 1480 | n/a |
| **Salween** | 2820 | yes |
| **Irrawaddy** | 2300 | yes |
| **Olenek** | 2270 | n/a |
| **Indigirka** | 1726 | n/a |
| **Khatanga** | 1634 | n/a |
| **Taz** | 1400 | n/a |
| **Kerulen / Herlen** | 1264 | n/a |
| **Anadyr** | 1150 | yes |
| **Australia / Pacific** | | |
| **Cooper Creek** | 1420 | n/a |
| **Sepik** | 1120 | n/a |
| **Fly** | 1040 | n/a |

| River (river basin) | Length (km) | Threat of modification |
|---|---|---|
| **Europe** | | |
| **Vychegda** (Northern Dvina) | 1130 | n/a |
| **Pechora** | 1809 | n/a |
| **Oka** (Volga) | 1500 | n/a |
| **Vyatka** (Volga) | 1370 | n/a |
| **Belaya** (Volga) | 1420 | n/a |
| **North America** | | |
| **Mackenzie** | 5472 | n/a |
| **Athabasca** (Mackenzie) | 1231 | n/a |
| **Liard** (Mackenzie) | 1115 | n/a |
| **Yellowstone** | 1080 | n/a |
| **Fraser** | 1370 | n/a |
| **Kuskokwim** | 1050 | n/a |
| **South America** | | |
| **Amazon** | 6516 | n/a |
| **Madeira** (Amazon) | 3239 | yes |
| **Jurua** (Amazon) | 3000 | n/a |
| **Xingu** (Amazon) | 2100 | yes |
| **Tapajos** (Amazon) | 1992 | n/a |
| **Putumayo / Ica** (Amazon) | 1575 | yes |
| **Maranon** (Amazon) | 1415 | n/a |
| **Madre de dios** (Amazon) | 1130 | n/a |
| **Purus** (Amazon) | 3379 | n/a |
| **Yapura** (Amazon) | 2820 | n/a |
| **Ucayali** (Amazon) | 2738 | n/a |
| **Mamore** (Amazon) | 1900 | n/a |
| **Beni** (Amazon) | 1599 | yes |
| **Huallaga** (Amazon) | 1100 | n/a |
| **Iriri** (Amazon) | 1300 | n/a |
| **Orinoco** | 2470 | n/a |
| **Guaviare** (Orinoco) | 1497 | n/a |
| **Pilcomayo** (Paraguay) | 2500 | yes |
| **Paraguay** (Parana) | 2549 | yes |
| **Araguaia** (Tocantins) | 2575 | yes |

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· ensuring that the use of renewable resources is sustainable
· promoting the reduction of pollution and wasteful consumption

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