Water for life:
Lessons for climate change adaptation from better management of rivers for people and nature

1. GLOBAL SUMMARY

The case studies

This report presents six cases where the work of WWF and its partners has resulted in adaptations in water management that are reducing vulnerability to expected climate change impacts, and are also improving the livelihoods of local people and enhancing the conservation of freshwater biodiversity. The six cases are:

1. **Lower Danube in eastern Europe;**
2. **Great Ruaha River in Tanzania;**
3. **Maner River, a tributary of the Godavari River in India;**
4. **Lakes in the central Yangtze River basin of China;**
5. **Rio Conchos in Mexico;**
6. **Rio São João in Brazil.**

THE ADAPTATIONS UNDERTAKEN

These six cases of adaptation were not explicitly designed to address the full impacts of climate change on these basins. High confidence climate change scenarios are not available for these river basins that would enable managers to adopt specific counter measures. Yet in each case there was knowledge of historical extremes that enabled “auto-adaptation” to manage in increasing uncertainty the impacts of floods and droughts, water scarcity and pollution.

The work of these projects involved social and institutional changes as much or more than biophysical and technological interventions to reduce vulnerability to the likely impacts of climate change. The adaptation tools and measures deployed included:

1. Decommissioning or changing the operations of under-performing infrastructure, like flood “protection” dykes and sluice gates;
2. Restoring the ability of the natural environment to provide ecosystem services, such as floodwater retention, storing water in aquifers, water purification and fisheries;
3. Adopting locally available and small-scale technologies, such as village water tanks;
4. Changing agricultural and aquacultural practices to more sustainable methods that: produce fewer pollutants; reuse water, such as for fish production then irrigation; are more water efficient; require less inputs; and secure higher returns for more valued produce;
5. Providing better waste management systems, especially for sewerage;
6. Diversifying local livelihoods into less water dependant enterprises;
7. Increasing the incomes derived from natural commodities, like fish, to reward producers adopting more sustainable practices and increase the resilience of these households;
8. Establishing and strengthening local institutions to facilitate adaptive management and self-determination, including establishing and enforcing more sustainable behavioural norms for uses of natural resources like water;
9. Facilitating basin-scale multi-stakeholder institutions to: establish partnerships; develop common visions; lead adaptive management; and connect the local to global measures needed for more effective adaption and sustainability;
10. Advocating for laws and government programs that facilitate subsidiarity, by providing basin and local institutions with the mandate and access to resources for adaptive management;
11. Improving connectivity in freshwater ecosystems by applying environmental flows, ensuring wildlife passage through or over water infrastructure, and restoring riparian habitats;
12. Restoring habitats to increase the resilience of these ecosystems to climatic impacts and their capacities to support greater populations of flora and fauna species, especially those that are threatened or of economic value.

Table 1 summarizes the main adaptation, livelihood and conservation benefits by project.

THE ADAPTATION OUTCOMES

The freshwater adaptation outcomes can be categorized as enhanced:

1. **Flood retention** – increased capacity to safely retain higher peak flood flows;
2. **Water security** – more reliable access to water in areas prone to scarcity;
3. **Pollution reduction** – cuts to pollution levels and the risk that pollution impacts like eutrophication will be exacerbated by higher temperatures;
4. **Livelihoods** – diversified income generation strategies and increased incomes of many participants that may increase resilience of communities to climatic events;
5. **Institutional capacity** – established and strengthened local institutions, increasing their adaptive management capacities;
6. **Connectivity** – re-linked habitats and populations of species, enabling greater mobility and capacity to colonize new habitats that may be required to survive in a warmer world;
7. **Populations and habitats** – restored populations of species and areas of habitat that may better resist and survive impacts of severe climatic events.

THE LESSONS LEARNT

These cases are historical examples from which we have derived higher-level lessons on how to help societies adapt to the commonly expected impacts of climate change on rivers and water resources. From the six cases presented in this report, the lessons derived are:

1. **Multiple benefits.** Many freshwater adaptations to climate change impacts are practical now, can be scaled up, and may have benefits for peoples' livelihoods and for nature conservation – they are "no regrets" measures;
2. **Communicating adaptation.** Better communication is required to inform and encourage local communities and governments, to overcome the perception of adaptation as a complicated process requiring new expertise to succeed;
3. **Local ownership.** Participation of local stakeholders in the design, implementation, and management of adaptation creates new societal norms that ensures the sustainability and effectiveness of the measures;
4. **Immediate benefits.** Local stakeholder support depends on receipt of immediate benefits, which may then engender support for more challenging measures;
5. **Adaptive management.** Adaptation is an iterative process requiring mainstream institutions to engage relevant stakeholders to work on and revise key measures over many years. River basin management organizations are key adaptation institutions in most societies;
6. **Linking local to national to global.** The most effective adaptations draw strength and link action at different geo-political scales. Sub-national governments were enthusiastic partners in these adaptation efforts, apparently motivated by vulnerability reduction and sustainable development opportunities. National laws and resource provision that support basin and sub-basin scale institutions appear vital for adaptive management of freshwaters. Basin and multi-lateral treaties are a catalyst for better river management in transboundary situations;
7. **Post disaster reform.** There is great impetus for adaptation following major natural disasters or severe environmental degradation that should be seized;
8. **Funding adaptation.** The social, institutional and environmental-focussed adaptations studied had a modest cost and were cheaper than identified impacts or alternative adaptations (such as large infrastructure projects). Upfront investment was required for necessary infrastructure, seed capital or loans, and to pay transition costs. The initial adaptation funding came from non-government organizations, development banks and other aid donors. National governments often contributed funding only after the adaptations had shown the potential to succeed.

DISCUSSION OF KEY ISSUES

The freshwater projects studied here are from sites where aquatic environments had been extensively degraded through desiccation, pollution and land use change. Consequent restoration of these sites suggests that practical and affordable adaptations of freshwater management can reduce vulnerabilities to climate change, and in many instances, also provide benefits for peoples' livelihoods and conservation of freshwater habitats. Two questions arise from these examples of generic adaptations: a) could more targeted and sophisticated programs achieve more, and b) could the resilience building adaptations implemented in these projects be overwhelmed as climate change impacts exceed key thresholds?

There is little doubt that more climate informed and target driven projects could achieve more effective adaptation, for example by better defining the freshwater biodiversity conservation objectives and the thresholds for the quantity and quality of water required to achieve them. In the Ruaha and Rio Conchos projects, the generic adaptations implemented on water scarcity are buying time and stakeholder ownership for the development of scientifically-based, quantitative environmental flows. This suggests that starting action to adapt to the most obvious problems should not wait for more precise information. By contrast, in the Yangtze and Danube, the floodwater retention capacities achieved by the restoration of floodplain sites are known and appear part of larger governmental decisions on the levels of acceptable flood risk.

If climate change impacts become more severe there is a risk that the adaptations to manage water scarcity and quality documented in these projects could be insufficient to meet the needs of people and the environment. Yet these resilience building measures have engaged and built the capacities of local institutions in adaptive management process that may provide the social and institutional resources needed to address greater climate impacts. These adaptations have bought time to consider whether more radical measures are required. By contrast, the increase in flood water retention capacity achieved in these projects will always be valuable. All of these adaptations have two prized qualities: they are "no regrets" measures, and they can be scaled up considerably to substantially increase resilience at a basin or greater scales.

While WWF and local institutions did not conceive these projects for comprehensive climate change adaptation, this varied from those explicitly addressing floods as a climate impact, to projects that had not thought of adaptation until it was raised by this study. The staff of WWF and their local institutional partners, that include people highly educated in relevant fields, had not focused on climate change adaptation. If these sorts of local thought leaders had not fully engaged in adaptation, why not? What would mobilize more regional societies to mainstream adaptation?

A common response of the local project staff when approached to participate in this research was that insufficient climate change impact data was available for their river basin to enable development of targeted adaptation responses. This suggests that awareness of climate change adaptation methods was low. Climate change adaptation proponents need to consider whether a mystique surrounding the data, methods and expertise required for effective adaptation is a barrier to implementation. In the Danube and Rio Conchos, however, some consideration of climate change was evident. Staff in all the projects were focused on reversing the severe environmental degradation evident in these basins. In number of the projects, as a result of participating in this research, the project staff have responded with renewed confidence that the adaptations they are implementing can be enhanced and become better climate-informed. This suggests that there are many local institutions that if directly engaged will consider climate change adaptation. It is also clear that many local people and institutions implemented these measures more for the short term livelihood and development benefits than reduction of long term risks. Proponents need to link adaptations to outcomes of value to local communities.

This research shows that adaptation is best considered as a pathway that starts by implementing the “no regrets” measures to address obvious vulnerabilities that most societies can undertake with locally available knowledge and technologies, often with a little external help. The small-scale but increasingly widespread local measures outlined in this report add up to substantial adaptation and buy time to consider and gather the resources needed if progressively harder adaptations are required. A number of these case studies exhibit a virtuous cycle where initial, successful interventions have generated stakeholder support and built capacities for progressively more sophisticated measures that will further enhance adaptation to climate change.

This report shows that practical adaptations to climate change impacts on freshwaters may have immediate benefits for peoples’ livelihoods and to conserve ecosystems, and should be priorities for governments and aid donors.

Table 1. Summary of key adaptation, livelihood and conservation benefits.

Project	Likely major climate change impacts	Key adaptation benefits	Key livelihood benefits	Key ecosystem benefits
Lower Danube, eastern Europe	Flooding increased. Pollution exacerbated. Biodiversity impacted.	Flood storage increased through restoration of floodplains. Plan to restore 2,250 km^2. 14.4% has been or is being restored. Pollution reduced.	Livelihoods diversified. Better access to clean water. Ecological services of €500/ha from restored floodplains.	Restored 4,430 ha of habitats and reconnected a 68 km^2 lake to the river. Fish and bird populations restored. Protected areas expanded by 5,757 km^2 in Romania.
Great Ruaha River, Tanzania	Greater water scarcity. Biodiversity impacted.	Reduced vulnerability to drought. Water Users' Associations and other basin institutions strengthened.	Established 20 Community Banks. Diversified into livelihoods with reduced reliance on water.	Flows restored in some places. Water sources and riparian vegetation restored. Tree felling for charcoal production reduced.
Godavari tanks, India	Greater water scarcity. Impacts of alternative adaptation options.	Greater surface and ground water access from restored tanks. Tank management systems established. Program adopted by the state government. Alternative to proposed US$4 billion dam demonstrated.	Increased agricultural production, employment and incomes. Reduced agricultural inputs. Cultural benefits.	Enhanced habitats for birds in the tanks. Alternative to environmental damage from proposed new dam demonstrated.
Yangtze lakes, China	Flooding increased. Pollution exacerbated. Biodiversity impacted.	Restored 450 km^2 lakes. Can retain 285 Mm^3 of flood waters. Reduced pollution. Government adopted restoration policies. Yangtze Forum established for adaptive management.	Improved access to drinking water. Fish resources increased. Diversification of livelihoods and increased incomes.	Restored 450 km^2 lake habitats, new 60 km^2 reserve. Populations of fish, birds and Yangtze Porpoise increased.
Rio Conchos, Mexico	Greater water scarcity. Biodiversity impacted.	Vulnerability to drought reduced. Established institution for adaptive basin management. Environment recognised as a user in the water law.	More secure access to water. Increased economic efficiency in agriculture. Enhanced livelihoods of communities in the headwaters.	Conservation of endemic fish. Developing payment for ecological services and environmental flows.
Rio São João, Brazil	Pollution exacerbated. Biodiversity impacted.	Pollution cut by 75%. Establishment of multi-stakeholder, adaptive, river basin management institutions. Management approach adopted nationally.	Restored 244 km^2 coastal lagoons rejuvenating tourism and fishing industries Training and economic diversification. Improved water supply.	Restored riparian, floodplain and lagoon habitats. Riparian corridors link remnant habitat of the threatened Golden Lion Tamarin. River connectivity restoration planned.

2. INTRODUCTION

Status of freshwater ecosystems

Freshwater habitats cover little of the earth's surface – by some accounts 0.8% – and support high biodiversity per unit area, with ~6% of the world's species being described from these ecosystems. The Millennium Ecosystem Assessment (2005) summarizes extensive losses of wetlands globally and describes freshwater ecosystems as being over-used, under represented in protected areas, and having the highest portion of species threatened with extinction. Primary direct drivers of degradation and loss include infrastructure development, land conversion, water withdrawal, eutrophication and pollution, over-harvesting and overexploitation, the introduction of invasive alien species, and global climate change.

Yet even without climate change, human pressures on freshwater ecosystems are growing rapidly, with increasing demands on limited water supplies for food production and low-carbon sources of energy. The United Nations 2015 Millennium Development Goals seek to halve poverty by, in part, extending water supplies and energy to the poor, and by expanding agricultural production. If poorly implemented, these agreements would further exacerbate the decline in wetland ecosystems.

Climate change impacts and freshwater

The Earth's changing climate is impacting directly on the distribution of water. The 2008 "Technical paper on climate change and water" from the Intergovernmental Panel on Climate Change (IPCC) summarises the expected bio-physical impacts:

- Precipitation and runoff is expected to increase in high latitudes, and decrease in mid and sub-tropical regions, exacerbated by greater evapotranspiration;
- Increased precipitation intensity and variability is projected to increase risks from floods and droughts;
- Melting glaciers may temporarily boost rivers flowing from major mountain ranges but reduced perennial base flows are anticipated in the long term;
- Increased temperatures and more intense rainfall are expected to aggravate pollution and sedimentation of water bodies;
- Changes in water quantity and quality are likely to affect food and availability, requiring demand and supply-side adaptations;
- The functions and operations of existing water infrastructure will be affected.

Freshwater dependant flora and fauna, which require specific volumes and quality of water at the right times to thrive, are being severely impacted. Ecosystems and species that require specific water flows face either contracting ranges or the need to move to new habitats. Migratory species that rely on particular water flow and temperate triggers for key stages of their life cycles could be particularly impacted. Species that require specific water temperatures to live and breed either need move to suitable refuges or face extinction.

The fragmentation of so many river systems by dams and other infrastructure creates barriers to adaptation for freshwater biota. There are two main adaptation measures that can be deployed for freshwater biodiversity conservation: a) maintain and enhance resilience of species populations and habitats in situ, such as by conserving riparian zones and providing environmental flows, or b) restoring connectivity of freshwater ecosystems, in part to facilitate migration by enhancing wildlife passage or removing redundant dams and dykes.

Clearly, far-reaching adaptations are required if people and nature are to weather the impacts of climate change on freshwater systems.

Many of the responses governments and societies make to climate change are also impacting on freshwater ecosystems and resources, and could be considered maladaptations. Policies to generate low carbon energy, for instance, can result in diversion of water for biofuel crop production, and with hydro-electric dams, fragmentation of rivers and changes to water flows. Greater storage and diversion of water is likely with increasing water scarcity and variability in runoff, further impacting on the ecological health of freshwater habitats. There is an urgent need to identify climate change responses that maximise the benefits for society while minimizing environmental impacts. Hence this research seeks to derive some relevant lessons on mutually beneficial adaptations from WWF field projects.

Adaptation

The IPCC defines adaptation as "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects". Resilience is "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self organization, and the capacity to adapt to stress and change" and is a subset of adaptation that represents less change from the status quo compared to other adaptation options.

The climate change debate until recently was characterized by political debates over the existence and severity of human-induced climate change, and the ongoing negotiations on how to limit greenhouse gas concentrations in the atmosphere. Only recently, as climate change impacts have manifest, have societies and governments focused on adaptation.

This study looks at existing cases of adaptation in river and water management to identify lessons that will help societies and governments adapt better to the impacts of climate change on freshwater systems to benefit both people and biodiversity conservation. The IPCC's Technical Paper on Water and Climate (2008) described such interventions as "autonomous adaptations … that do not constitute a conscious response to climate stimuli, but result from changes to meet altered demands, objectives and expectations which, whilst not deliberately designed to cope with climate change, may lessen the consequences of that change."

2. INTRODUCTION CONTINUED

Adaptation and freshwater

The six WWF freshwater conservation projects examined were not explicitly designed to address the impacts of climate change. The case studies were selected because all water management is adaptation. The IPCC's Fourth Assessment Report states that "Adaptation to changing conditions in water availability and demand has always been at the core of water management." Historically human societies have continually implemented measures to reduce vulnerability to floods and droughts, and to improve access water of a usable quality. These hydrological events and problems are the types of impacts expected with greater severity from climate change. By assessing major new adaptations undertaken in the WWF projects, lessons are derived as to what factors motivated societies and governments to change their water management, how adaptation can be made more effective, and what barriers need to be overcome for better adaptation.

High resolution climate change scenarios are not available for these river basins that would enable managers to adopt specific counter measures. It is questionable whether climate change scenarios will have fine enough resolution in the foreseeable future to do so. Yet in each of these cases there was knowledge of historical extremes that enabled informed action to be taken to reduce the expected impacts from more frequent floods and droughts, and from water scarcity and pollution. Three types of autonomous adaptations are studied in these projects:

1. Improved water management, including for flood retention, water security and pollution reduction;
2. Strengthened societies, through enhanced livelihoods and increased institutional capacities;
3. Enhanced environmental resilience, from restoring connectivity, species' populations and habitats.

These adaptations apply existing tools, including social, institutional, environmental and small scale technological adaptations. They are compared in some case studies to large scale infrastructure adaptations represented by the status quo (such as flood protection dykes) or a proposed new dam in India. The alternative infrastructure adaptations often have two drawbacks: they are predicated on a largely stationary climate and hydrological regime and may become redundant with further climate change, and they usually have long term and often irreversible negative impacts on people and ecosystems. It is also possible that in future the impacts of severe climate change may exceed thresholds at which the adaptation measures researched in this report can sustain the needs of people and biodiversity. This question is considered further in the global summary.

3. CASE STUDIES

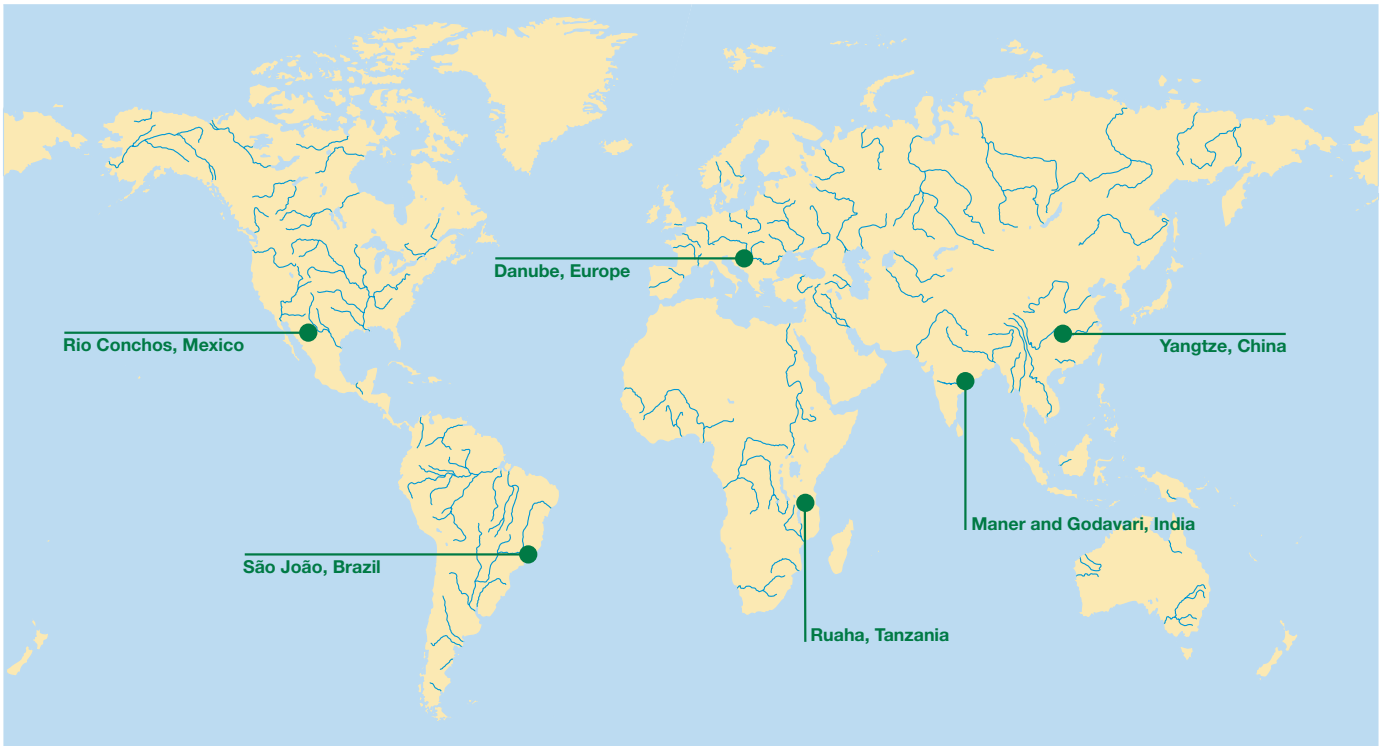
This report describes six cases where the work of WWF and its partners has resulted in major adaptations to water management that are reducing vulnerability to climate change, and are also improving the livelihoods of local people and enhancing the conservation of freshwater biodiversity. The six cases are:

1. Lower Danube in eastern Europe;
2. Great Ruaha River in Tanzania;
3. Maner River, a tributary of the Godavari River in India;
4. Lakes in the central Yangtze River basin of China;
5. Rio São João in Brazil;
6. Rio Conchos in Mexico.

The analytical framework adopted for this study is detailed in the Annex.

This section introduces and then evaluates the six case studies by examining improvements in resilience to climate change, livelihood changes, and conservation of biodiversity. Key questions asked are:

- What motivated these societies to change?
- Whether these adaptations sustainable?
- Who paid and how will the adaptations be maintained?
- What barriers were encountered and lessons learnt?
- How could these adaptations be scaled up?



3.1 DANUBE: LOWER DANUBE

Background

Falling within the territories of 19 European states, the 801,000 km^2 Danube River is home to 81 million people. The 2,800 km long river is one of the largest sources of nutrients into the Black Sea, which suffers from a hypoxic "dead zone". Conversion of floodplains for farming and other development has seen 95% of the upper Danube, 75% of the lower Danube and 28% of the delta's floodplains cut off by dykes. This has exacerbated flood peaks. In 2005 a flood killed 34 people, displaced 2,000 people, inundated 690 km^2 and caused US$625 million (€396 M) in damages in Hungary, Romania, Bulgaria and Moldova. A year later a flood displaced 17,000 people, inundated 1,450 km^2 and cost US$8.6 million (€5.5 M) in Romania. Climate change is expected to increase the frequency of floods and exacerbate pollution.

WWF's interventions

WWF commenced work in the Danube in 1992 and promoted the establishment of the Convention for the Protection of the Danube River in 1994 and European Union (EU) Water Framework Directive in 2000. In 2000 WWF secured agreement from the heads of state of Bulgaria, Romania, Moldova and Ukraine to restore 2,236 km^2 of floodplain to form a 9,000 km^2 "Lower Danube Green Corridor." This Corridor is intended to attenuate floods, restore biodiversity, improve water quality, and enhance local livelihoods. Pilot projects to demonstrate floodplain restoration assessed in this case study are the 1993-1996 removal of the 36.8 km^2 Babina and Cernovca polders in Romania, and in Ukraine in 2005-2008 the relinking of the 68 km^2 Katlabuh Lake to the river and removal of the 7.5 km^2 Tataru polder.

Adaptation outcomes

If the 2000 Lower Danube Green Corridor agreement to restore a floodplain area of 2,236 km^2 were fully implemented, this would significantly reduce damage from floods. As at 2008, 469 km^2 of floodplain, 14.4% of the area pledged, has been or is undergoing restoration. The restored 21 km^2 Babina Island polder holds 35 Mm^3 in floodwaters at high tide. These pilot restoration sites are in the Danube delta where the flood safety benefits are less than sites located further upstream. An extra 2.1 Bm^3 in flood retention capacity through the restoration of floodplains and former side channels would lower Danube flood peaks by 40 cm. Further, identification by WWF of potential floodplain restoration sites that coincide with biodiversity conservation priorities is aiding governments to better target their flood control interventions.

Livelihood outcomes

Reduced vulnerability to floods is a major benefit for peoples' livelihoods from the floodplain restoration work. Most of the polders targeted for conversion were used for cropping and forestry, activities that were not very profitable since the change from centralized economies in the 1990s and due to land degradation. Restoration of the pilot polders has seen a diversification in livelihood strategies to fishing, tourism, reed harvesting and livestock grazing on seasonal pastures, activities that earn an average €40 per hectare per year. Each hectare of restored wetland is calculated to produce 34 kg of commercial sized fish per year, and at the 36.8 km^2 Babina and Cernovca polders, the restored fisheries provide jobs for 20-25 people. At Katlabuh Lake, improved water quality will enhance access of 10,000 local residents to drinking and irrigation water. Provision of ecosystem services like restored floodplain for fisheries, forestry, animal feed, nutrient retention and recreation is valued as €500/ha/yr, or around €85.6 million per year for the pledged 2,236 km^2 restoration area.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3.1 DANUBE: LOWER DANUBE

Environmental outcomes

The restoration of the 9,000 km^2 Lower Danube Green Corridor is enhancing biodiversity conservation and resilience to some impacts of climate change, including from extreme events and changes in water quality. For instance, following restoration of the 21 km^2 Babina Island polder, the number of resident bird species increased from 34 to 72, and over a quarter of the waterbird species commenced breeding. After the Lower Danube Green Corridor pledge and as a result of its EU accession, Romania designated an additional 5,757 km^2 as Natura 2000 protected areas.

Motivations for change

Local communities and national governments undertook floodplain restoration to: reduce vulnerability to flooding, improve water quality, and more increase local incomes. National governments are seeking to fulfil their obligations under regional agreements of the EU, and Danube River Protection Convention, to adopt new and more sustainable river management practices. The expansion of the EU into eastern Europe has been one driver for reform of river basin management.

Sustainability and funding

Reversion is unlikely because: the cost of re-building flood "protection" dykes is very high; in most cases the restored floodplains are designated as protected areas; local peoples' livelihoods have improved; and the threat from flooding remains. Management costs of the restored floodplains are low.

Barriers and lessons

Government implementation of restoration of the lower Danube floodplain has been slow: it has taken too long to appoint officials and agencies to lead the work; to develop national implementation plans; and allocate funds. Most of the funding for floodplain restoration has come from the EU, NGOs and other donor organizations. In some instances local people have not consented to restoration, and changes in land laws have hindered progress.

Making use of post-disaster policy windows is a key lesson. The policy of floodplain restoration is viewed much more favourably following the 2005 and 2006 floods, for instance, Romania is currently completing a national floodplain restoration strategy. Persistent work over more than ten years has been required to achieve the outcomes to date. Linking and drawing strength from simultaneous work at the pilot site, national, basin and European scales has been critical to achieving reforms.

Potential to scale up

Based on the Romanian pilot projects, WWF estimates that dyke removal costs €50 – 200,000 per kilometre, depending on the nature of the dyke wall, plus compensation for changes in land use. From this work WWF has calculated that restoration of four polders covering 1,000 km^2 in Romania, which flooded in 2006, would cost around €20 million and hold 1.6 Bm^3 and generate ecological services worth €50 million per year. Further, restoration of the 37 sites that make up the Lower Danube Green Corridor is estimated to cost €183 million, compared to damages of €396 million from the 2005 flood and likely earnings of €85.6 million per year. Clearly floodplain restoration is a cost effective adaptation that can be increased in the Danube basin.

Conclusions from the Danube

The large-scale adaptation in the Danube shows the value of restoring the natural resilience of the environment to climate events by decommissioning under-performing water infrastructure, in this case by more safely retaining and releasing peak floods. It also highlights how replacing vulnerable monocultures with more diverse livelihoods based on natural ecosystems (in this case tourism, fishing, grazing and fibre production) can strengthen local economies. International agreements for better water and river management have been a powerful driver of change in the Danube.

3.2 TANZANIA: GREAT RUAHA RIVER

Background

Tanzania's Great Ruaha River is a major tributary of the Rufiji River, and is nearly 600 km long. The 84,000 km^2 basin is home to 6 million people. The 280 MW Mtera and Kidatu hydroelectric project on the river represents 48.5% of Tanzania's installed electricity generation capacity. The river basin contains two major wetlands: Utengule (upstream) and Ihefu (downstream), the Usangu Game Reserve, and Ruaha National Park, which encompasses the Ihefu wetlands and part of the river downstream from it. In the river headwaters, 46% of the 1.5 million residents live in poverty. The average income is US$0.80 per day and it is a largely agriculture-based economy. Between 1970 and 2002, the area devoted to irrigation increased from 10,000 ha to 45,000 ha. A range of crops are grown, predominantly rice under irrigation in the semi-arid and sub-humid portions of the catchment.

The Great Ruaha was a perennial river. From 1957 rainfall in the lowland portion of the catchment declined, a trend many fear will be exacerbated by climate change. Increasing degradation of the catchment was also evident. From 1993 in the dry season (July – November) there were zero flows in long stretches of the Great Ruaha River downstream from the Ihefu wetland. This had major impacts on the livelihoods of local people and on the riparian environment, and raising concerns for tourism and hydropower generation. In March 2001, Prime Minister Frederick Sumaye announced "that the Government of Tanzania is committing its support for a program to ensure that the Great Ruaha River has a year round flow by 2010."

WWF's intervention

WWF's program to restore flows in the Great Ruaha River commenced in 2003, working with communities in eight of 16 districts in the basin, focussed on better catchment management and poverty reduction. Local Water Users' Associations (WUAs) were established to restore catchments and better manage water by: restoring the source catchments; agreements with major agricultural users to better schedule their water diversions; and enforcement of water laws to shut down illegal diversions. Headwaters and riparian zones were restored by: reducing vinyungu (valley-bottom) farming, removing thirsty, exotic trees; restoring indigenous vegetation, including by reducing felling for charcoal production; protecting riparian zones from grazing; and relocating houses from river banks (80 of 150 have been relocated so far). Agreements with irrigators have reduced transmission losses through coordinated water deliveries, and reduced dry season water use. A 49,000 m^3 dam was constructed to secure a water supply for livestock. Each sub-catchment WUA required a month of training and cost US$13-27,000 to establish. Community Conservation Banks were also established for savings and micro-credit. Each of the 20 banks started with a loan of US$4,000 (since repaid) and 30 members, or ~150 beneficiaries counting family members.

Adaptation outcomes

Year round river flows into the Ihefu wetlands restarted in 2004. Restored flows and stronger local institutions have reduced the vulnerability of local people to water scarcity. The WUAs are represented in river basin governance processes for the implementation of the Tanzanian Government's new water policies.

3.2 TANZANIA: GREAT RUAHA RIVER

Livelihood outcomes

Livelihood strategies have diversified from agriculture, brewing and charcoal production into activities requiring less water, notably retailing, manufacturing clothing, and bee-keeping. Secure water supplies have supported livestock production, and fish farming in water storages has proved particularly profitable. Training in better production practices of 48 rice farmers has seen some double their yields.

Environmental outcomes

The conservation of riparian zones and restoration of springs and river flows is of benefit to biodiversity. Flows have recommenced into the Ihefu wetlands, and the number of zero flows downstream into the National Park has been reduced to less than a month per year. A flow assessment is now underway to rigorously determine the water required to conserve particular environmental attributes.

Motivations for change

Local communities were keen to implement these adaptations due to their vulnerability to water scarcity and pollution, and need to improve their livelihoods to reduce poverty. For the Tanzanian Government, the project has attracted resources to implement its water policies in the basin.

Sustainability and funding

The sustainability of these adaptations, such as enforcement of water rules, depends on ownership and implementation by the local community, which is likely given the strengthened local institutions and livelihood benefits derived thus far. Funding has so far come from WWF and the EU. There are US$951 million in national and donor funds held by the Tanzanian Government for use to 2011 to support this type of water sector development nationally. The government's intention to foster this type of river basin management through a new water law, and allocation of central funds and fees from water users to local management institutions, is yet to be realized. Further, the Tanzanian Government has a policy of expanding irrigation, which if implemented poorly in the Great Ruaha River basin, may impact further on river flows.

Barriers and lessons

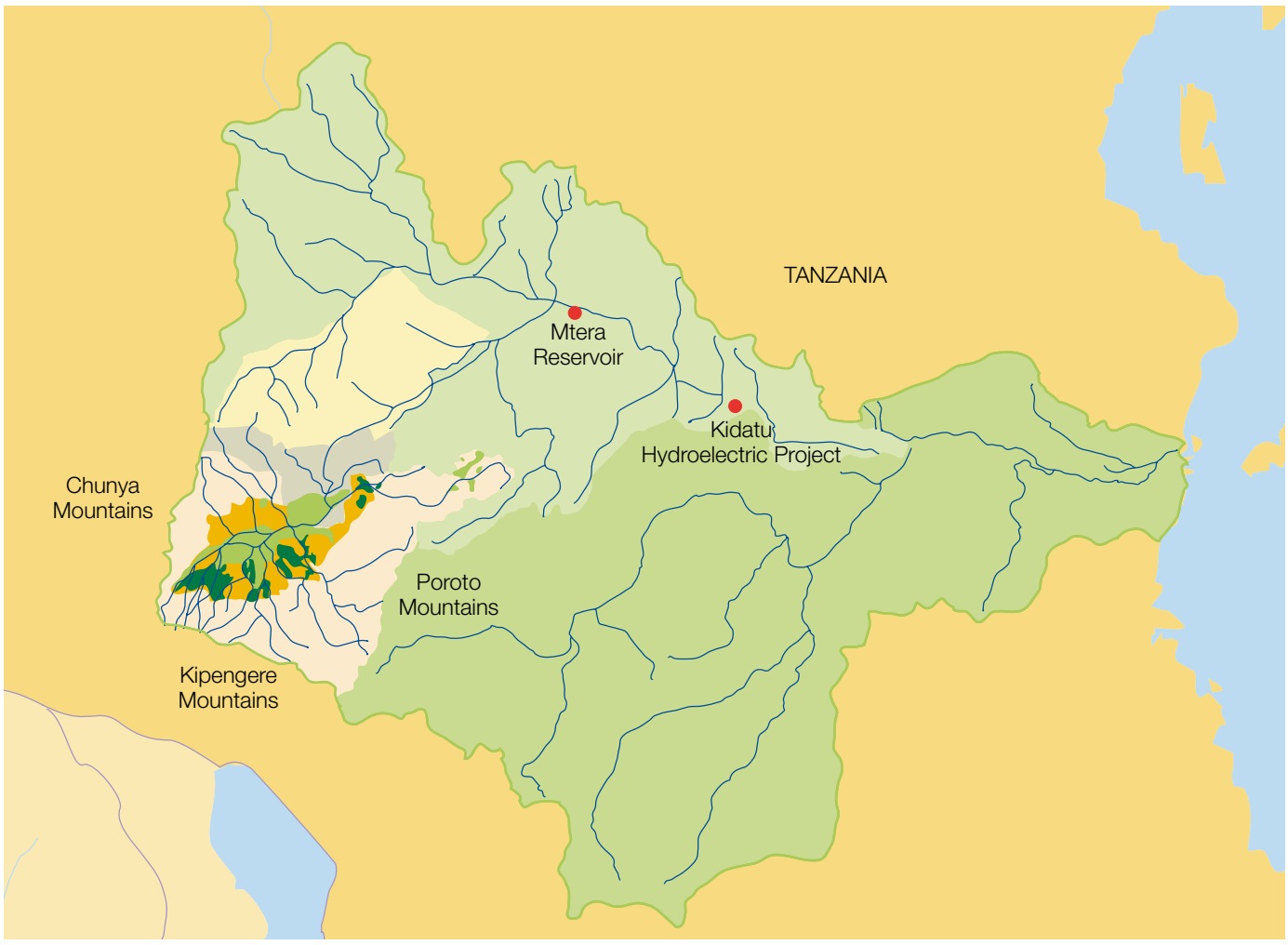
Work with government agencies locally was hampered as newly trained officers took up better employment offers elsewhere. Lessons for successful adaptation from the program are that: seed funding is essential for the transition; improvements in livelihoods motivates change; establishing and strengthening local institutions, and links to basin and national institutions, make this change sustainable. Reduced poverty, better livelihoods and stronger local institutions are resulting in more sustainable catchment management.

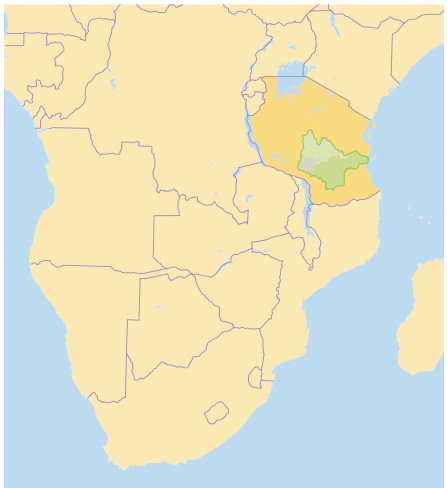
Potential to scale up

This approach to adaptive catchment management could be scaled up given its modest cost and the national and donor funds available in Tanzania and other countries.

Conclusions from Tanzania

The inexpensive, grass roots adaptation measures applied in the Great Ruaha demonstrate how incremental action to restore ecosystem functions and better manage natural resources can increase resilience to water scarcity. It highlights the importance of strengthening the capacities of local people and organisations to improve governance, diversify the local economy and institute adaptive management practices. This case also emphasises the need for governments to support local organisations with appropriate mandates and financial independence to undertake ongoing adaptive management.





Rufiji Basin
Great Ruaha River Catchment
Usangu area
Ruaha National Park
Usangu Game Reserve
Wetlands
Irrigation
Rivers

3.3 INDIA: TANKS IN ANDHRA PRADESH

Background

The 1,465 km long Godavari River drains a 313,000 km^2 basin in central India, and is home to around 63 million people. Nearly all rain falls in the monsoon from June to October, usually in only 100 hours, making storage essential for year round water access. The low confidence climate change scenarios for peninsula India suggest that slightly more precipitation is possible.

Beginning around 1,200 year ago, villages constructed "water tanks", earth dams that range in area from less than one to more than 100 hectares, with most being one to ten hectares in size. The tanks were managed in a way that benefited the elites in society. From the late 1940s tank maintenance largely ceased as state governments purported to take over their management. Subsequently the population has increased six-fold, the capacity of tanks decreased, and most natural surface waters are fully diverted in the dry season. Loss of surface waters has driven over-exploitation of ground waters, further threatening security of supply. Poverty, limited water supplies, drought, costs of seed and farm chemicals, and iniquitous financing by suppliers jeopardizes the lives of many farmers, resulting in a wave of farmer suicides.

The growth in India's population and its economy is dramatically increasing demand for water, with water use expected to increase by 53 to 85% from 2000 to 2050. The governments have plans for massive new water infrastructure projects, such as the US$135 billion national "Interlinking of Rivers" scheme. The Andhra Pradesh Government's proposed US$4 billion Polavaram Dam on the lower Godavari River, for instance, would displace 250,000 people, inundate key habitats – including 60,000 hectares of forest – to supply irrigation water.

WWF's intervention

WWF began a pilot project in 2004 with a local NGO, Modern Architects for Rural India and local villages, to assess the costs and benefits from restoration of tanks. The Maner River, a tributary of the Godavari draining a 13,000 km^2 basin was chosen for this project. The basin is home to 3.8 million people. The average income is US$1.34 per day: under– and un-employment is at 50%. Remote sensing was used to map the distribution and area of tanks. In 2005 and 2006, in the 88,000 ha Sali Vagu sub-catchment, 12 tanks with an area of 11 hectares and serving 42,000 people were restored through de-silting. The US$103,000 intervention was undertaken with funding of $28,000 from WWF and $75,000 from farmers in cash and labour.

Adaptation outcomes

To capture and store more monsoon runoff, 73,000 tons of silt was removed from the tanks. The increased water supply and groundwater recharge resulted in less groundwater pumping. Water tables rose, reactivating some wells that had dried up, wells worth an average US$2,330 each. An additional 900 ha was irrigated. The silt comprised 60-70% clay rich in carbon and nutrients, and was spread over 602 ha. Village committees were established to maintain the tanks and manage water use. Following the success of this project, the state government has started a tank de-silting program.

External boundaries of India as depicted are neither correct nor authenticated.

3.3 INDIA: TANKS IN ANDHRA PRADESH

Livelihood outcomes

The fields that received the silt were owned by 884 farmers, 96% of whom held less than two hectares and 78% of whom were from disadvantaged classes. Crop yields increased significantly, by +1.1 t/ha for maize and +0.4 t/ha for tumeric, increasing total production by Rs 5.8 million (US$69,600) per annum. The additional lands irrigated produced crops worth Rs 1 million (US$24,000) per annum. Wages paid for de-silting the tanks were Rs 0.5 million (US$12,000). Farmers reported increased fodder for milk production, a lower incidence of pests due to healthier plants, decreased application of farm chemicals, and less electricity use for pumping. In addition, use of 5 x 2 m deep ponds covering 2,000 m^2 for fish production in the tanks provided a net profit of Rs 160,000 (US$3,700). Other livelihood benefits reported included: enhanced self-determination of the villages; improved supplies of water for domestic, livestock and washerman use; reduced urban migration; less conflict over water; greater participation of women in decision making; and enhanced value of the tanks for spiritual, religious and ceremonial purposes.

Environmental outcomes

The tank restoration improved artificial habitat for migratory and water birds, including with the establishment of 16 island refuges. Of greater environmental significance is the potential for tank restoration to meet India's soaring water demands, where feasible, in place of proposals for large scale water infrastructure developments. In the Maner River basin there are 6,234 water tanks covering 588 km^2 that could be de-silted by 3 m at an estimated cost of Rs 25.5 billion (US$635 million) to store an extra 1,961 Mm^3 (compared to estimated water use in the basin today of 2,000 Mm^3 pa) at a cost of US$0.32/$m^3$. Further, this water would be stored widely across the basin where more people can access it. By contrast, the government's proposed US$4 billion Polavaram Dam would store 2,130 Mm^3 irrigation water at a cost of US$1.88/$m^3$. The tanks are filled once whereas the dam may be refilled during the year if there are adequate inflows. Never the less, the tank restoration is clearly a viable alternative to the maladaptation of dam construction.

Local motivation for change

The local villagers were motivated to participate in the tank restoration as it would reduce their vulnerability to water scarcity by increasing storage.

Sustainability and funding

The increased incomes and other livelihood benefits ensured that the tanks will now be maintained. Management will be undertaken by village committees. Wide-scale tank restoration requires initial investment in de-silting, that was provided by WWF and matched in-kind by the villagers in this case.

Barriers and lessons

This decentralized adaptation succeeded because work with the villages was demand-led, respected their needs, utilized locally available technologies, and provided immediate benefits.

Potential to scale up

There is huge potential for tank restoration to contribute to adaptation and sustainable development as there are 208,000 village tanks across India.

Conclusions from India:

The Maner River project shows how building community capacities, applying technologies that are locally available, and undertaking small-scale measures could add up to effective and inexpensive large-scale and pro-poor adaptation. This contrasts sharply with the negative consequences of the inflexible, large infrastructure alternative, namely: cost; constraints on scaling up implementation; displacement of people; limited capacity for village self-determination; fewer benefits for the poor; and substantial environmental impact.

3.4 CHINA: LAKES IN THE CENTRAL YANGTZE RIVER BASIN

Background

The 6,300 km long Yangtze River drains a 1,800,000 km^2 basin and is home to around 400 million people. Along the central Yangtze, extensive lakes and floodplains of great environmental importance as well as forming retention areas that attenuated the large summer floods. In the last 50 years in Hubei Province, of 1,066 lakes, 757 covering 2,150 km^2 were converted to polders reducing wetlands area by 80% and flood retention capacity by 2.8 Bm^3 or 75%. Damage from four major floods between 1991 and 1998 resulted in up to thousands of deaths and billion of dollars in damages.

The low resolution climate change scenarios for the Yangtze basin are compounded by other hydrological developments. Never the less a greater frequency of extreme floods and droughts is anticipated, even if average precipitation may not change greatly. Lakes were polluted, including by application of fertilizer to aquaculture pens. The loss of connection to the Yangtze River prevented diluting flows and migration of fish. Recently, drought has increased water pollution, and higher temperatures with climate change are expected to exacerbate eutrophication.

WWF's interventions

In 2002 WWF commenced a program to reconnect lakes in Hubei Province to the Yangtze River through opening the sluice gates, and facilitate sustainable lake management. The program focused on three lakes: Zhangdu (40 km^2), Hong (348 km^2) and Tian'e Zhou (20 km^2). Alternative and more sustainable livelihoods for local residents was a priority, in an area where the average income is just US$1.34 per day. In conjunction with this work, WWF formed partnerships with government agencies and others to explore options for more sustainable river basin management.

Adaptation outcomes

From 2004-2005 in Hubei Province the sluice gates at lakes Zhengdu, Hong and Tien'e zhou have been seasonally re-opened and illegal and uneconomic aquaculture facilities and other infrastructure removed or modified. The success of these adaptations was replicated by the Anhui Government at Baidang Lake (40 km^2) from 2006. Now these 448 km^2 wetlands can store up to 285 Mm^3 of floodwaters, reducing vulnerability to flooding in the central Yangtze region, although this has not yet been tested in practice. Cessation of unsustainable aquaculture, better agricultural practices, and reconnection to the Yangtze River has reduced pollution levels in these lakes. Pollution fell at Lake Hong from national pollution level IV (fit for agricultural use only) to II (drinkable) on China's five point scale. Subsequently, the Anhui Government has reconnected a further eight lakes at Anqing covering 350 km^2.

These successes on the ground have informed parallel efforts to strengthen institutions. The biennial Yangtze Forum was established in 2005, bringing together the different tiers of Chinese governments and other stakeholders to share perspectives, integrate data, and develop a vision for harmonious management of the river basin.

Livelihood outcomes

Of immediate benefit was the increase in wild fisheries species diversity and populations. Within six months of reconnection of Zhangdu lake the catch increased by 17.33% and nine fish species returned to the lake. Similarly the catch increased by 15% in Baidang Lake. Development of certified eco-fish farming by 412 households increased income of fishers by 20-30% on average. Similarly, the income from fisheries at the Yangcai Hu area of Hong lake increased by 25% after restoration. Bamboo farming has commenced, especially to stabilize steeper lands near the lakes. Access to cleaner water supplies is another benefit.

3.4 CHINA: LAKES IN THE CENTRAL YANGTZE RIVER BASIN

Environmental outcomes

The habitat restoration has increased wildlife diversity and populations. Twelve migratory fish species returned to the lakes. Hong Lake supported only 100 herons and egrets when polluted, but after restoration 45,000 wintering water birds, 20,000 breeding birds and the endangered Oriental White Stork returned. Tian'e zhou lake is the site of the managed populations of the threatened Pere David's Deer and Finless Porpoise, whose population has increased from 24 to 40. At Zhangdu Lake, 60 km^2 of lake and marshland was designated as a nature reserve by the Wuhan Municipal Government. To strengthen the effectiveness of wetland conservation efforts in the Yangtze River basin, a Nature Reserve Network was established to link 17 nature reserves (12 recently designated) covering 4,500 km^2. As a result of these benefits, in 2006 the Hubei Provincial Government adopted a wetlands conservation master plan and allocated resources to protect 4,500 km^2 by 2010.

Motivations for change

Local communities and governments were motivated by better access to clear water, diversification of the local economies, and increased incomes. The governments sought to implement their policy of harmonious development between people and nature, and central agencies are concerned to reduce flood risk.

Sustainability and funding

Government agencies have adopted the new lake management regimes into their standard operating procedures and allocating funding for ongoing implementation. Nationally, there is the capacity to fund more lake reconnection should the central government support expansion of the program.

Barriers and lessons

Altering flood control measures is controversial in any society, and in this case it took the greater threat of floods plus the prospect of enhanced livelihood to gain support to reconnect the floodplain lakes. Demonstrating that adaptations can work "in the field" was vital to learn by doing and to secure external support for wider application at provincial and national scales. Adaptation to the needs of governments and other stakeholders was essential for gaining support and ownership.

Potential to scale up

There are many hundreds of sluice gates along the Yangtze River that cut off lakes, so there is considerable potential to scale up this approach. Further, this floodplain restoration strategy offers an alternative to the maladaptation of cutting more wetlands off from the river, as is proposed at Poyang Lake.

Conclusions from China

This case shows the value of restoring the natural resilience of the environment to climate events, in this case by restoring connectivity between the river and lakes by improving operations of under-performing water infrastructure. Assisting the local community to adapt their aquaculture and agriculture to more sustainable practices has enhanced their livelihoods and the environment. Working in partnership with government agencies has ensured that these changed practices are now mainstreamed in daily operations, and has seen these measures adopted at other lakes.


Qinghai Hu
Xining
Lanzhou
Hwang Ho
Zhengzhou
Xuzhou
Hongze Hu
Gaoyou Hu
Nantong
Nanjing
Shanghai
Tai Hu
Xi'an
Huang He
Chao Hu
Shaoxing
Hangzhou
Gyaring Hu
Ngoring Hu
C H I N A
Baidang
HOH XILSHAN
BAYAN HAR SHAN
Chang Jiang
Zhangdu Hu
Wuhan
Yichang
Hong Hu
Tian-e-zhou Hu
Poyang Hu
Wenzhou
Nanchang
TANGGULA SHAN
Y A N G T Z E
Dongting Hu
Chengdu
Qamdo
B A S I N
Chongqing
Changsha
Fuzhou
Nam Co
Leshan
Luzhou
Gongga Shan
Lhasa
HENGDUAN
Hengyang
DALOU SHAN
Zhangzhou
Xiamen
Taiwan Strait
Guiyang
Sadiya
Putao
Thimphu
Brahmaputar
NAN LING
Shantou
Liuzhou
Guangzhou
Xiaguan
Kunming
Myitkyina
Gauhati
NAGA HILLS
DONGNANG PLATEAU
HONG KONG
MACAO
Imphal
Salween
AILAO MTS.
Gejiu
Nanning
Ha Giang
Pingxiang
Zhanjiang
Dhaka
Lashio
Mekong
VIETNAM
Dien Bien Phu
Hanoi
Haiphong
Qiongzhou Haixia (Hainan St.)
Haikou
Chittagong
ARAKAN YOMA
Mandalay
PEGU YOMA
LAOS
Gulf of Tongkin
Hainan
SOUTH CHINA SEA
BURMA
Louang Prabang
Irrawaddy
Akyab
Xieng Khouang
Vinh
THAILAND
Vientiane
Yangtze Basin
Rivers

3.5 MEXICO: RIO CONCHOS

Background

The Rio Bravo/Grande basin is shared by Mexico and the USA. The countries adopted a water treaty in 1944 that obliges Mexico to deliver 432 hm^3 (0.432 km^3) water from a major tributary, the Rio Conchos. The 750 km long Rio Conchos is located in Chihuahua State, and has a 67,000 km^2 basin that is home to around 1.3 million people. Irrigated agriculture is a major industry in the largely semi-arid basin, but more water rights were issued than the river could reliably sustain. Perennial rivers ceased to flow year round and over-exploitation of groundwater ensued. Freshwater habitats in the basin are particularly important for conservation of endemic fish and other species. A long drought in 1994-2006 placed Mexico in arrears in its treaty obligations to deliver water, and in 1999 the Rio Bravo/Grande failed to reach the sea for the first time. Severe droughts are known from the pre-historic record, and climate change predictions for the area suggest a similar drying trend.

WWF's interventions

A program was established in 2002 with four main interventions: reform of the irrigation industry, better management of the headwaters (not discussed further here), strengthening institutions, and environmental flow determinations.

Adaptation and livelihood outcomes – irrigators

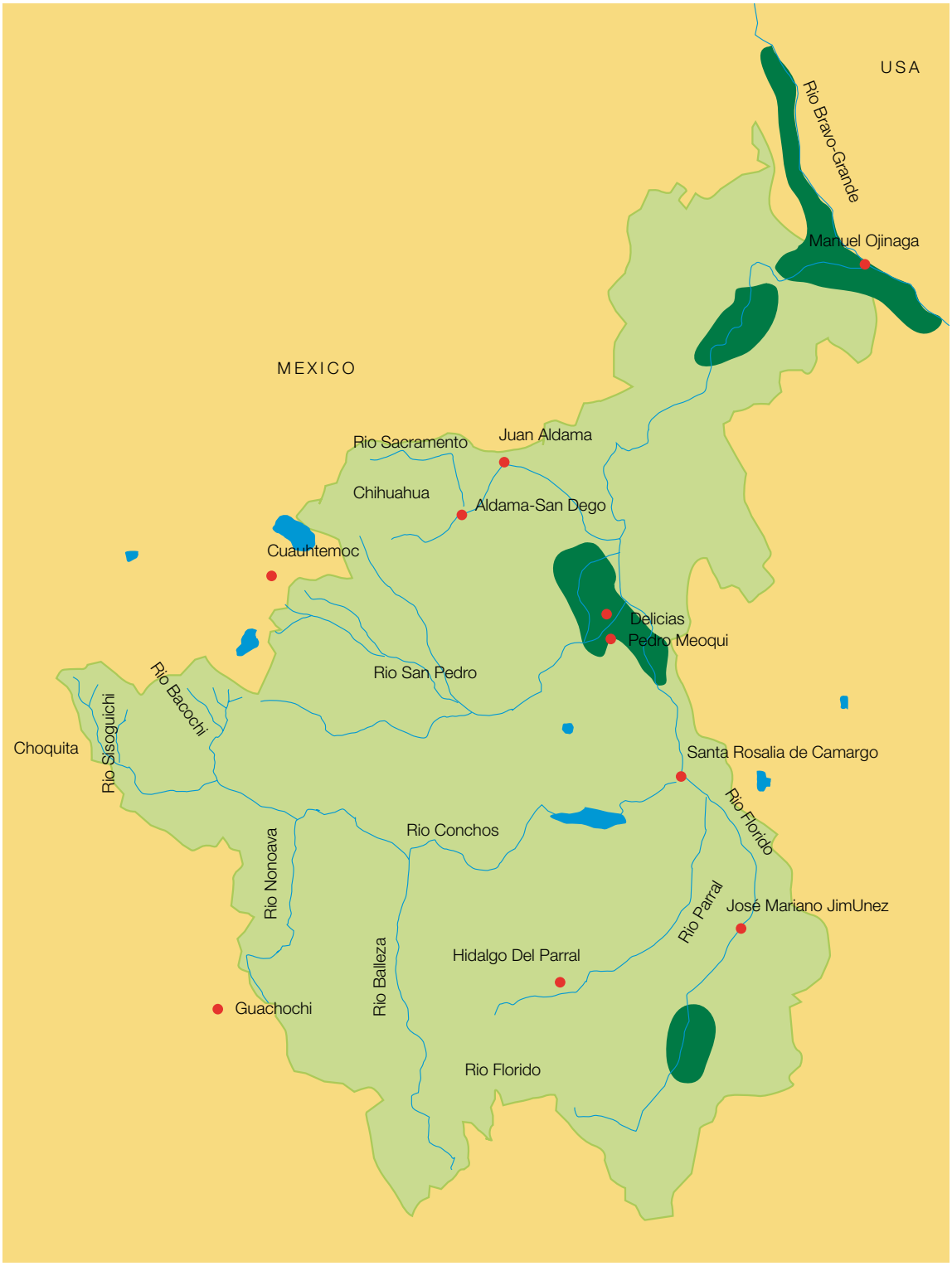
In 2002 WWF undertook a study of the Delicias district, the basin's largest irrigation area with allocated water rights of 942 hm^3/yr, or 83% of the water allocated for use in the Rio Conchos. This was a catalyst for a North American Development Bank (NADB) funded program from 2003 of US$140 million to reduce surface water demand, and the volume of water required to produce each unit of the main crops fell by 25-34%. The focus on surface water use efficiency proved to be a maladaptation, as the water that was not used in crop production contributed to groundwater recharge, and by reducing this without controlling groundwater use, water security declined further. A more holistic approach was adopted: increasing purchase and retirement of water rights, and adding groundwater management and water law enforcement measures. Water use has been reduced by 200 hm^3 pa, significantly increasing the reliability of water supply and the economic efficiency of the remaining right holders. Further efficiencies of up to 400 hm^3 pa are possible.

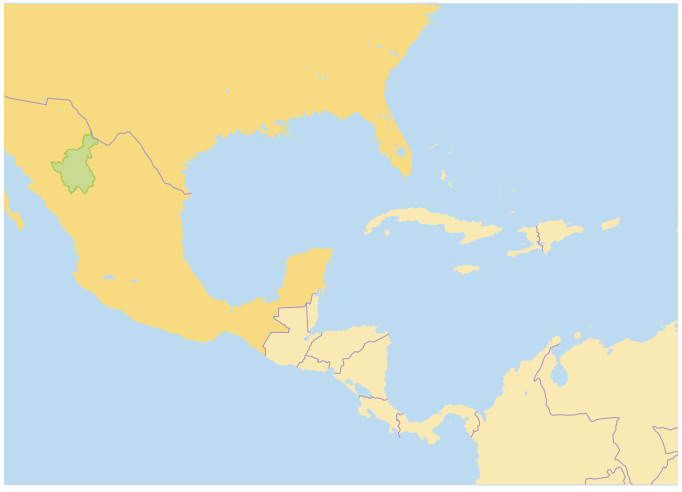
Adaptation and livelihood outcomes – institutions

WWF advocacy in 2004 led to changes national water law, recognizing the environment as a water user. Also in 2004 WWF established the Inter-institutional Working Group (GIT) to bring together key government and non-government stakeholders to promote sustainable basin management. GIT provides a common platform for collaboration, by contrast with the non-operational Rio Conchos Basin Commission, which is mandated by the water law with membership restricted to water right holders. In 2005 GIT was endorsed by the Chihuahua Government and now coordinates investments by state and federal governments, including US$3.2 million for 65 activities in 2005, and US$4.4 million for 60 activities in 2006. Negotiations are underway for the GIT to be recognized as part of the Commission.

Environmental outcomes

Environmental flows were determined to quantify how much water is needed conserve particular biota and how best to deliver them. An index of biological health was developed to quantify the state of riparian sites, set targets for improvements, and measure changes. Flow requirements were assessed using the Building Block Method for nine sites and require, in part a maintenance flow of 226 hm^3/yr. This compares to the treaty requirement to deliver an average 432 hm^3/yr downstream and the mean annual runoff of 683 hm^3 from the Rio Conchos into the Rio Grande/Bravo. Negotiations are underway with the national water agency, CONAGUA, and GIT on implementation of





Watershed
Irrigation
Rivers
Reservoirs

3.5 MEXICO: RIO CONCHOS

environmental flows. The basin hydrological model developed for the environmental flows determination was adopted by CONAGUA and provided warning to implement dam safety measures when the 2006 flood commenced.

Motivations for change

Vulnerability to drought and security of water supplies was the key motivation for all basin stakeholders. The need to meet treaty obligations influenced the national government and regional institutions.

Sustainability and funding

For moderate climate change, such as the WWF estimate of a 6.2% increase in evapotranspiration with 3degC rise in mean annual temperature reducing Rio Conchos flows by 25 hm^3/yr, the adaptations appear sustainable because of the: scale (200 hm^3/yr) of reduction of over allocation achieved; modest scale of environmental flows required to sustain biodiversity, which is less than the flows required to meet treaty obligations; and strengthening of institutions. However, these adaptations may be vulnerable to more severe climate change impacts forecast for similar systems that are highly sensitive to changes in precipitation and evapotranspiration. In Australia's Murray-Darling basin, for instance, one forecast is for a fall in inflows by 55% with a 2degC rise in mean annual temperature by 2060.

The significance of the Rio Conchos' waters has seen substantial investments by the NADB and governments. Many adaptations required upfront capital and require lower ongoing maintenance costs. It is of concern that state administrative procedures currently block payment for environmental services fees via water users' bills, and the multi-stakeholder basin organization, GIT, does not have a mandate in national law.

Barriers and lessons

This case highlights the need for adaptation measures to consider conjunctive and sustainable management of surface and ground waters and the importance of water law enforcement. In Mexico, the portion of water that is extracted without a permit is believed to be in the range of 40 to 60% of sustainable yield in water stressed areas. A campaign to close illegal wells and enforce water laws commenced in the Delicias irrigation district in 2008. A relatively complex method was used to determine environmental flows when WWF staff believe that it may have been politically preferable to apply a quicker, cruder, interim method in order to commence flows sooner. The Rio Conchos also highlights the value of effective multi-stakeholder processes for adaptation, even when they lack a legal mandate.

Potential to scale up

The adaptations undertaken have cost US$140 million in a one-off modernization of irrigation and ~US$4 million per year to manage the basin more sustainably. This is a model that could be adopted more widely in Mexico.

Conclusions from Mexico

The essential need for conjunctive management of surface and ground waters is an important adaptation lesson from the Rio Conchos. The project also highlights how it is possible to reduce demand for water and vulnerability to water scarcity. Acting now to attenuate the most obvious impacts while developing more sophisticated and precise measures, as shown with environmental flows, is a key feature of adaptation in this example. The Rio Conchos also demonstrates the value of multi-stakeholder institutions and international agreements in facilitating and driving adaptive management.

3.6 BRAZIL: RIO SÃO JOÃO

Background

Brazil's south-east coast is a popular holiday destination, with the biodiverse Atlantic forest remnants giving way to farm lands, lagoons that supported an extensive fishing industry. In the 3,825 km^2 São João region, east of Rio de Janerio, the resident population of 451,000 people swells to around 2 million people in holiday periods. The Juturnaiba Dam on the 120 km long São João River is the main water supply. The largely uncontrolled tourism development resulted in the coastal lagoons becoming polluted with untreated sewerage, causing a collapse in the fishing industry and impacting on tourism. Climate change forecasts for this region of Brazil lack high resolution, however, impacts are expected from more extreme events, and higher temperatures may exacerbating water pollution and impact on temperature-sensitive aquatic wildlife.

WWF's interventions

WWF was a catalyst for the establishment of a multi-stakeholder organization to promote sustainable management of the Rio São João and smaller adjacent catchments in the São João national hydrographic region. It successfully advocated for river basin based management to be a key approach in the 1997 national water law. In 1999 the Consorcio Intermunicipal Lagos São João (CILSJ or Consortium) was formed by the 12 local governments and now includes four stakeholder representatives from the São João Basin Committee. This Committee was established in 2004 with membership from governments, academics and 58 civil society groups to engage basin residents and advise the Consortium. Designation of the Committee under the national and state water laws has enabled it to levy fees on water users for basin management in accordance with its work plan. Establishment of a number of sub-basin and thematic working groups has facilitated widespread participation in adaptive basin management, increasing local capacities. These institutions were established for integrated river basin management, to progressively solve major environmental problems, starting with water pollution and fisheries management.

Adaptation outcomes

The degradation of the rivers, Juturnaiba reservoir (30 km^2), and Araruama (220 km^2) and Saquarema (24 km^2) coastal lagoons by discharge of untreated waste waters threatened the tourism and fishing industries that are 70% of the region's economy. Renegotiation of water supply company concessions saw an initial US$38.5 million investment in 2002-05 in new sewerage treatment infrastructure that has reduced wastewater discharge by 75%. A US$19.3 million second phase is due to collect all waste waters for collection by 2009, and a third phase from 2010-23 is planned to separate storm water for sewerage. In addition the silted up entrance to the Araruama Lagoon was dredged to restore greater exchange of water with the sea. The substantial reduction of pollution inflows has ended eutrophication of lagoon waters and reduced the threat from higher temperatures with climate change.

Livelihood outcomes

Improved water quality has seen restoration of mangrove habitats and increases in fish, shrimp and bird populations. The fishing industry that supports 600 families has been restored, and the tourism industry has recovered. Economic growth is increasing regional training and employment opportunities.

Environmental outcomes

Work is underway to conserve the water sources and biodiversity through linking and restoring remnant riparian and other wetlands habitats. The Juturnaiba Dam will be retrofitted with a US$400,000 fish ladder to reconnect populations of migratory species like grey mullet, sea bass and prawns. The bypass canal downstream of the dam will be decommissioned at a cost of US$700,000 to restore the Rio São João's natural course and adjacent flood plains. The canal will be converted to aquaculture

3.6 BRAZIL: RIO SÃO JOÃO

ponds, further diversifying the local economy. A payment for environmental services scheme is funding previously unemployed residents to restore riparian forests. This is linking remnant habitats of a threatened primate, the Golden Lion Tamarin, whose population is increasing as the forests are restored. A network of protected areas are being established on private and public lands to further conserve natural habitats. Biodiversity and the fishing industry are expected to benefit further as reconnection and restoration of habitat increases species populations, access to habitat, ability to move to new habitats, and thus resilience to climate change impacts.

Motivations for change

The collapse of the coastal lagoon environments and consequent impacts on the fishing and tourism industries was the initial motivation for reform. The Consortium's staff say that community awareness raising and engagement, and a virtuous and iterative cycle of successful interventions has led to public support for further actions. This has enabled the Consortium and Committee to broaden the scope of their work and raise funds locally for river basin management activities.

Sustainability and funding

Institutional sustainability of these adaptations is assured based on the strength of the local organizations, mandate from the national water law, and the direct fundraising capacity of the Consortium through a levy on basin residents.

Barriers and lessons

Until this study commenced, the basin management organization had not considered how its adaptations built resilience for climate change, as opposed to what they then saw as more immediate problems. The program's staff are now inspired to reassess how their program can now become more climate informed and effective for climate change adaptation. This case study highlights the importance of strong local institutions for adaptation. The extensive civil society communication and engagement has made government institutions more accountable and responsive. The multi-stakeholder Committee and Consortium processes built partnerships and consensus for change, and stopped "buck-passing" between governments. The basin institutions' subsidiarity mechanisms enhanced local ownership of problems, innovation and successful responses. An iterative and virtuous cycle of projects implementation generated positive results that built support for new actions. The Consortium secretariat was kept small and work was contracted out to other institutions in the basin, enhancing ownership, partnerships and capacities for reform.

Potential to scale up

The national water act that provided the mandate for the Consortium at São João, and its powers to raise funds and administer adaptation projects could enable similar work in the ~140 similar basin institutions across Brazil.

Conclusions from Brazil

The key conclusions from adaptation at São João are institutional. Establishment of effective, local multi-stakeholder institutions that practised subsidiarity has engaged a broad spectrum of the local community and empowered them to take action to restore their environment. This was partly possible due to effective national and state water laws that gave the basin institutions mandates and access to adequate funding sources. The basin institutions have taken an iterative, adaptive management approach to addressing environmental problems, and by achieving substantial early successes, have inspired community confidence and further support for new interventions.

São João Basin
Rivers
Lagos São João Consortium and Committee region

4. CONCLUSIONS

Freshwater resources and ecosystems are under great threat from non-climate related demands and problems, and water managers are focussed on finding sustainable solutions to these pressing challenges. The daunting and global nature of climate change appears to have further dissuaded many influential local water management institutions from engaging in climate change adaptations. A common perception that particular expertise, data and methods are needed appears to have stalled active consideration of the issue and opportunities. Yet the six projects studied in this report show that when adaptation measures are considered in the context of common problems in water management, many practical ways of building resilience to climate change through mainstream programs are evident.

The adaptations studied may not have been designed to reduce specific climatic vulnerabilities to a quantifiable level, but they are “no regrets” measures that have attenuated known risks, have bought time, can be scaled up, and have strengthened and engaged local institutions to achieve more. This report shows that practical adaptations to climate change impacts on freshwaters, which have benefits for peoples’ livelihoods and for nature conservation, may have immediate benefits and should be priorities for governments and aid donors.

ANNEX: ANALYTICAL FRAMEWORK

The cases are the portfolio of international freshwater programs funded in large part by WWF UK, in three instances, with sponsorship from HSBC from 2002 – 2006. Each of the projects was developed and implemented largely autonomously by the local WWF office. The projects were required to follow WWF network procedural standards for project design, monitoring and reporting.

This assessment was undertaken between February and June 2008 and sponsored by the HSBC Climate Partnership. Each WWF project was funded to employ a local consultant reporting to the local office to prepare a case study report responding to an analytical framework, which covers the background to the work, and the outputs and lessons in three areas: adaptation, livelihoods and conservation. The following questions were applied to each of the six cases. The six case studies have then been analysed by the author.

A. Background & overview

Place/river basin

Country

Why it is an example of climate change adaptation

Summary (of sections B-D):

- Change in climate change resilience
- Change in livelihoods
- Change in conservation status

Key lessons

- What worked
- What did not work well

Timeline of processes and WWF and partners' interventions

Quality of the data. If any of the questions below could not be answered, why not?

Main actors – their roles & relationships:

- Government agencies: local/provincial or state/national/multilateral
- Business
- Community
- Multi-stakeholder

What intra– and inter-governmental processes were used?

What elements made interactions between these stakeholders positive or negative?

ANNEX: ANALYTICAL FRAMEWORK

B. Climate change adaptation

1. What was the baseline situation?
2. What are the natural historic climatic and hydrologic risks in the area?
3. How do local people cope with these risks traditionally?
4. What increased risks are forecast with climate change?
5. What are the project's climate change adaptation outcomes? Can these be quantified? To what extent are these based on having more resilient institutions?
6. Were these planned or serendipitous?
7. Were these planned to address a future forecast threat (eg. potentially larger floods; greater water scarcity) or were they intended to incrementally improve management of an existing problem (eg. current flood levels; current water shortages)?
8. Is the improvement in climate change adaptation sustainable?
9. Why has the project been successful in improving climate change adaptation?
   - What activities have been carried out at the macro, meso and micro scales?
   - Which formal institutions were in place that have contributed to a favourable outcome?
   - Which informal institutions were in place that have contributed to a favourable outcome?
   - What assumptions were made before the project was implemented & were these realistic?
   - What was the timeframe within which benefits could be measured?
   - How were local people, their knowledge & needs integrated into the project?
   - Which partnerships with stakeholders were established in the project and what roles did these play?
10. What should be done differently for similar projects in future?
11. Can you compare the outcomes in the project site compare to a similar place that was not involved in the project?
12. What needs to be done to ramp these adaptation techniques up to the basin scale and what would it cost?

C. Socio economics

1. What was the baseline situation?
2. What are the project's livelihood outcomes?

a. More income?

b. Increased well-being?

c. Reduced vulnerability?

d. More sustainable use of the natural resource base?

3. What is the distribution of socio-economic benefits?

a. Gender?

b. Age groups?

c. Income groups?

d. Disadvantaged groups (HIV/AIDS, unemployed, disabled, etc)?

4. What would have happened to people's livelihoods without the project?
5. Is the improvement in livelihoods sustainable?

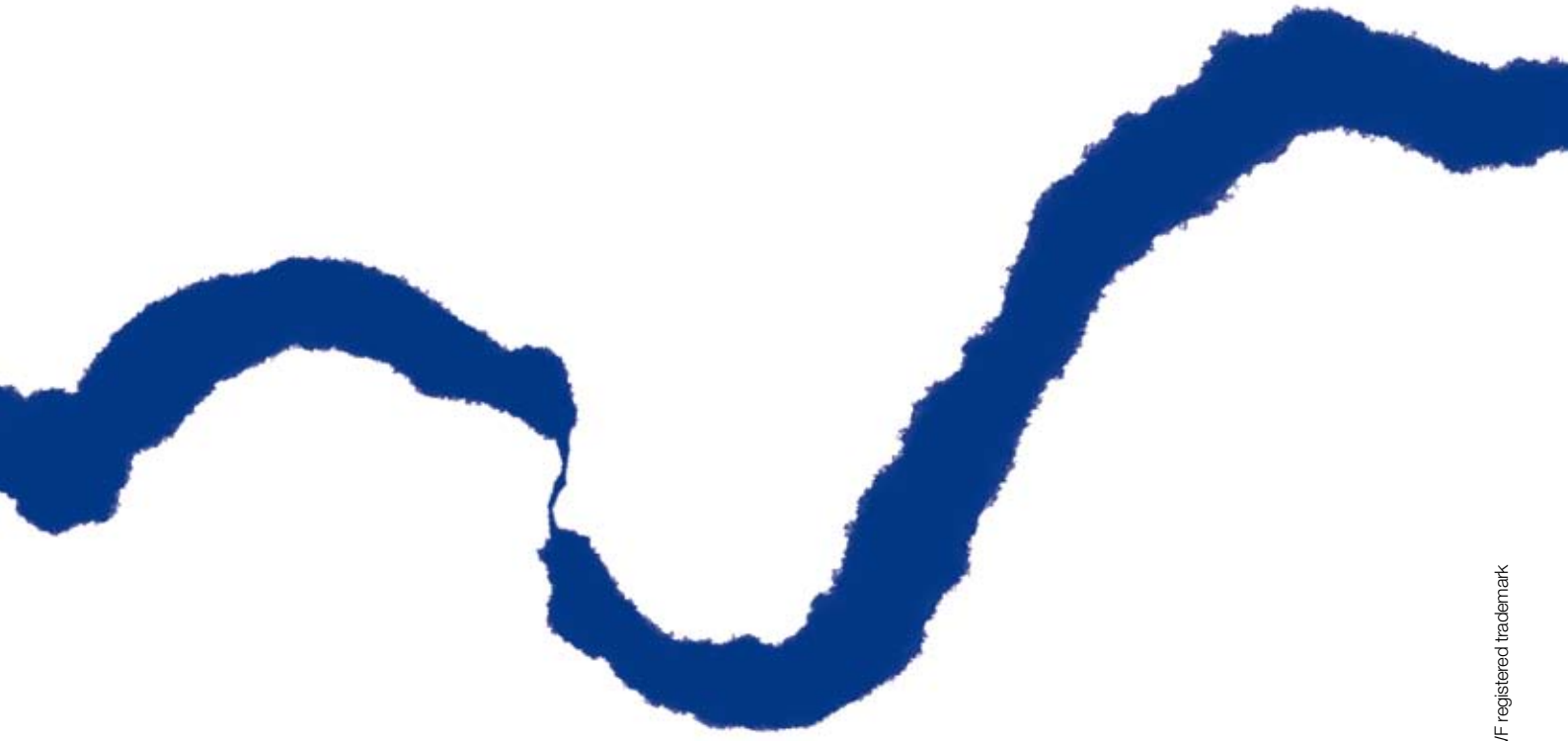
6. Why has the project been successful in improving livelihoods?
   - What activities have been carried out at the macro, meso and micro scales?
   - Which formal institutions were in place that have contributed to a favourable outcome?
   - Which informal institutions were in place that have contributed to a favourable outcome?
   - What assumptions were made before the project was implemented & were these realistic?
   - What was the timeframe within which benefits could be measured?
   - How were local people, their knowledge & needs integrated into the project?
   - Which partnerships with stakeholders were established in the project and what roles did these play?
7. What should be done differently for similar projects in future?
8. Can you compare the outcomes in the project site compare to a similar place that was not involved in the project?
9. What would be the socio economic impacts of business as usual and what is the benefit of magnifying the project to the other relevant parts of the river/basin? Balance this with what it would cost to implement these adaptation techniques in the above section.

D. Conservation

1. What was the baseline situation?
2. What was the conservation objective/s of WWF's intervention/s
3. What are the project's environmental outcomes?
4. Is the improvement in conservation sustainable?
5. Why has the project been successful in improving conservation?
   - What activities have been carried out at the macro, meso and micro scales?
   - Which formal institutions were in place that have contributed to a favourable outcome?
   - Which informal institutions were in place that have contributed to a favourable outcome?
   - What assumptions were made before the project was implemented & were these realistic?
   - What was the timeframe within which benefits could be measured?
   - How were local people, their knowledge & needs integrated into the project?
   - Which partnerships with stakeholders were established in the project and what roles did these play?
6. What should be done differently for similar projects in future?
7. Can you compare the outcomes in the project site compare to a similar place that was not involved in the project?
8. What would be the impact of business as usual and the conservation/ecological benefits of ramping up to the river/basin scale?

About WWF

With a global network covering more than 100 countries and nearly 50 years of conservation work behind us, WWF is one of the most experienced environmental organisations in the world, actively contributing to delivering freshwater projects and programmes around the world.



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Formed in 2007, the HSBC Climate Partnership brings together HSBC, The Climate Group, Earthwatch Institute, Smithsonian Tropical Research Institute and WWF to tackle the urgent threat of climate change on people, water, forests and cities.

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The mission of WWF is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:
· conserving the world's biological diversity
· ensuring that the use of renewable resources is sustainable
· reducing pollution and wasteful consumption

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