Controlling Yangtze River Floods: A New Approach

World Resources Report Case Study

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INTRODUCTION

One of the most striking features of climate change in Asia is the change of the monsoon system, bringing new precipitation patterns to China. This has resulted in more flooding resulting from severe precipitation in southern China, and more droughts in the northern part of the country. Starting in the early 1980s, the Chinese government undertook research projects to better understand the risks of climate change and identify adaptation measures (Zhang and Wang 2007; Editorial Committee 2007). Severe flooding in 1998 convinced the government to take immediate action to adapt to climate change. This case study assesses institutions in China that have been established to manage flooding in the Yangtze River basin and their subsequent incorporation into the holistic National Climate Change Programme (GoC, 2007). Like most climate change adaptation actions in other parts of the world, China's flood management measures are multi-objective and multi-benefit driven interventions.

The Yangtze is one of the most important rivers in China and is subject to flooding in the summer monsoon season. The growing risk to people, ecosystems, and the economy of flooding in the central and lower Yangtze region was partly due to reclamation of floodplains for agriculture and increasing siltation from erosion in the watershed. There is also increasing concern that climate change may cause more frequent extreme floods in the Yangtze basin (Editorial Committee, 2007, Xu and Ma 2009).

In a break from the past, the Chinese government focused on environmental restoration – a 'soft path' (Gleick, 2002) – rather than engineering solutions. The 1998 "32 Character Policy" comprised four major elements: (a) increasing forest coverage by enhancing forest protection and afforestation of steep farmlands; (b) restoring floodplains by removing embankments and returning agricultural polders to floodplains to increase floodwater retention capacity; (c) resettling farmers by building new townships and providing them with jobs instead of subsidies; and (d) strengthening other levees and dredging riverbeds (CCICED, 2010). The restoration of 2,900 square kilometers of floodplains has substantially increased flood retention capacity, improved biodiversity

conservation and generation of ecosystem services, and improved the livelihoods of local people.

This intervention was successful because the Chinese government's cross-sectoral National Development and Reform Commission (NDRC) developed an integrated policy and oversaw its implementation. This program has informed China's national policies for creating a moderately prosperous ecological civilization through national five-year plans with measures for "harmony" between people and nature, and between wealthy, urban communities and poorer, rural communities. Restoration of floodplains is one of the adaptation measures adopted in China's National Climate Change Programme (GoC, 2007), which is a de facto recognition that the limits to cost-effective engineering solutions (e.g. raising dikes, which increases both costs and the risks to populations should they fail) have been reached, as well as an acknowledgement of the co-benefits of healthy floodplain ecosystems. A number of challenges remain in maximizing the benefits from floodplain restoration, including: holding decision-makers accountable for implementing the policies well; conflicting sectoral laws; promoting the quality of outcomes as well as meeting targets for quantity; and ensuring adequate payments for providers of ecosystem services (CCICED, 2010).

SETTING

The Yangtze is the longest river in China, stretching 6,300 km and draining a basin covering 19 provinces over an area of 1.8 million km^2 (Yang et al., 2009)(Figure 1). The growing impacts of monsoon flooding in the central Yangtze region threatened local people and the economy, culminating in a 1998 flood that killed more than four thousand people and inflicted economic losses of US$25 billion (Yu et al., 2009, WWF, 2003). Over 400 million people live in the basin, which produces 40% of China's gross domestic product (Yang et al., 2009), prompting this intervention by the Chinese government to better manage the flood risk.

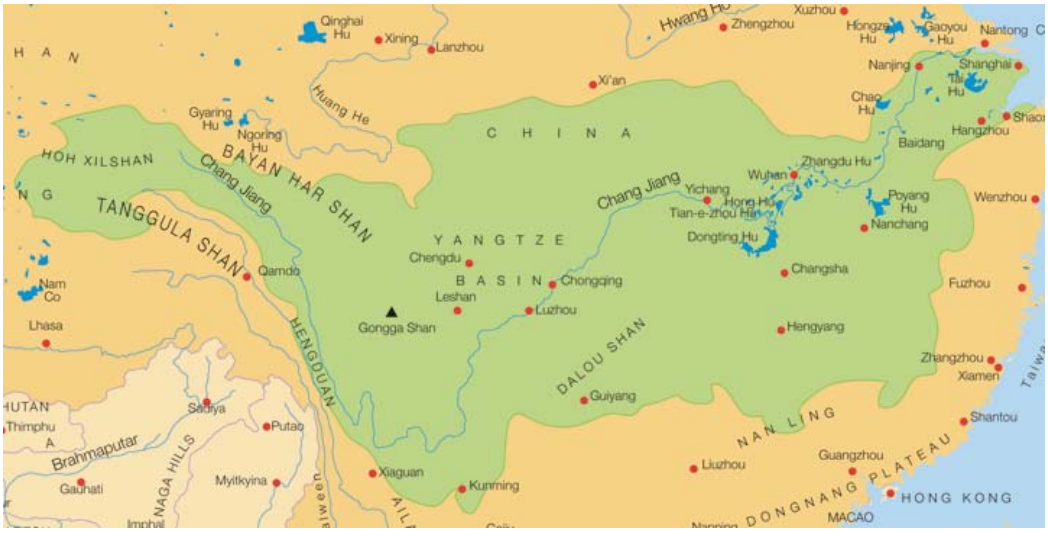

Figure 1: Location of the central floodplains wetlands downstream of Three Gorges Dam on the Yangtze River, China (© WWF UK, 2008).

The increased frequency of dangerous flooding was attributed to a number of causes, including reclamation of floodplain areas for agriculture, which forced floodwaters into smaller areas with higher flood peaks that are harder to contain (Yu et al., 2009). Another factor was increasing erosion in the watershed, leading to silting up of the central Yangtze lakes and floodplain areas that could safely hold and

slowly release flood peaks. In Hubei Province, floodplain wetlands were reduced in area by 80%, reducing flood retention capacity by 75% or 2.8 billion m^3 (Yu et al., 2009). Similarly at Poyang Lake in Jiangxi Province, since the 1950s, the lake area has been reduced from 4,500 km^2 to 3,100 km^2, cutting flood retention capacity by 30% (~6 billion m^3) (CCICED, 2010). In total, more than 3,000 km^2 of wetlands disappeared in the Yangtze River basin from the early 1950s to the late 1990s. In addition, there is increasing concern that climate change may be causing more frequent extreme events in the Yangtze basin, especially flooding (Editorial Committee, 2007; Jiang et al., 2008; Xu and Ma 2009).

The Yangtze River basin headwaters contain extensive, high-altitude grasslands and forests. The predominant land use on the floodplains is agriculture, in particular rice production, which is not a lucrative crop. Extensive fishing and aquaculture occur in the water bodies. The Yangtze River is one of the world's most biodiverse for fish species and is home to threatened species, including the Yangtze River Dolphin and Sturgeon, and migratory water birds (IUCN et al., 2003, Yang et al., 2009, CCICED, 2010). Large urban areas have also grown up on floodplain areas, including the cities of Wuhan, Changsha and Nanchang.

The local people and infrastructure are regularly threatened by floods. As local levee banks are up to 37 m high, breaks in the levees can cause catastrophic damage and loss of life. Throughout Chinese history up to 1998, government policies focused on building larger levees and cutting off floodplain lakes from the river channels, but this has exacerbated the flood risks. This engineering-focused approach did not work well or failed for a number of reasons. Old levees were designed according to past climate regimes and cannot withstand large floods that are becoming more frequent with climate change. Due to the high costs of building larger levees, most levees were only built to withstand a one in 20 or 30 year flood event. However, floodplain reclamation and climate change has increased the frequency of extreme floods in the Yangtze River basin as evidenced by the large 1998 and 2010 floods. The time and cost required to maintain levees is a significant burden on local people, particularly for the poorer rural villages who have constructed polders without central government approval or support. Further, the levee system has created secondary problems, including reduced quality of water bodies cut off by the levees from the river.

TYPES OF RISK FACED

While the interventions described in this case study were not necessarily designed in response to human-induced climate change, there are many lessons learned that can be applicable to adapting to a changing climate both within China and for other countries facing similar risks.

The large size and diversity of landscapes means that the climate and climate change impacts vary across the Yangtze basin. There is disagreement in the climate models as to changes in average precipitation across the Yangtze River basin; however, all assessments concur that more frequent flooding and other extreme events are likely across the basin due to increased monsoon intensity (Jiang et al., 2004, Jiang et al., 2008, Xu and Ma 2009).

These flood events arise quickly and can cause great loss of life and damage if dikes fail. Flood risk is highest in the central Yangtze River basin, where many large tributary rivers converge and where the floodplain area has been reduced the most. In the lower basin there is a higher risk of flooding from the combination of sea-level rise, storm surges and flooding (CAS et al., 2007; Xu and Ma 2009). Consequently the change in flooding is primarily a change in variability, and is the primary risk that inspired the government to intervene.

In addition, the observed rise in average temperature is likely to further exacerbate the existing, secondary problem of eutrophication from pollution (CAS et al., 2007; Xu and Ma 2009). The headwaters are experiencing severe aridity and erosion, and the resulting sediment is likely to reduce the operational life of the extensive system of hydropower dams being constructed in the upper basin (CAS et al., 2007, Xu and Ma 2009).

A recent and comprehensive vulnerability and adaptation assessment of the Yangtze basin (CAS et al., 2009) identified vulnerabilities in water resources and for coastal cities, as well as reduced agricultural production, changes in forests, degradation of alpine grasslands, and changes in wetlands. Seven adaptation strategies were recommended:

1. Reducing vulnerabilities of essential infrastructure and communities;

2. Promoting integrated river basin management, including ecological water management;

3. Adjusting cropping systems to changed climate;

4. Protecting natural forests;

5. Reducing human impacts on alpine grasslands;

6. Restoring wetlands; and

7. Promoting low-carbon development.

The impacts of climate change largely exacerbate risks from pre-existing changes to the basin, such as the floodplain reclamation described above, which are the result of human activities rather than climate change. For example, as a result of excessive erosion in the basin and sedimentation of the wetlands located between the dikes, human activities (specifically forest restoration and closure of the Three Gorges Dam) have depleted the Yangtze River of sediment. As the channel is now eroding, it threatens to strand wetlands higher up on the floodplain and undermine riverside flood levees.

The closure of the Three Gorges Dam and construction of additional dams in the basin are changing water flows to the detriment of freshwater ecosystems. Dams and sluice gates are also a barrier to fish migration and breeding, and a number of species are now threatened (CAS et al., 2007). Further, extensive pollution, over-harvesting of aquatic biota, and shipping traffic have all severely impacted the river ecosystem (CAS et al., 2007). The South to North Project, an inter-basin water transfer scheme from the Han River, a major tributary of the Yangtze River, will diminish river flows (CAS et al., 2007). Reoperation of hydropower stations as run-of-the-river dams, provision of environmental flows, reopening sluice gates, and floodplain restoration can all help reduce these impacts (Opperman et al., 2009, Krchnak et al., 2009).

It is notable that a number of the actions impacting the Yangtze River, including the expansion of hydropower production and the South to North Project, are climate change mitigation and

adaptation measures favored in China's National Climate Change Programme (GoC, 2007).

The snail-borne disease *schistosomiasis* is endemic in the floodplains of the central Yangtze region. A secondary reason for restoring the floodplains was to relocate residents out of the most infested, core wetland areas.

This case study focuses on rural communities living on the central Yangtze floodplain. Traditionally these communities have often relied on monoculture production of rice or aquaculture products, leaving these people poor and vulnerable to disruption from floods. In some communities, transition to flood-adapted and more diversified production systems has greatly improved their resilience, as discussed below.

POLICY INTERVENTION

Following the 1998 floods, the Chinese government mandated its powerful, cross-sectoral NDRC to develop an integrated "32 Character Policy" (Wang et al., 2007). This policy was backed up by policy directives, targets, substantial funding, and reporting mechanisms to enable effective implementation at the provincial and county scales. The policy is proactive, long term (to 2030), flexible (with China's five-year national planning cycle), and robust in that floodplain restoration is a 'no regrets' measure.

Initial Approach: Restoring Floodplains

The key element of the policy discussed in this case study is the restoration of floodplains and relocation of vulnerable communities – the initial approach. Nationally, a policy of restoring 14,000 km^2 of natural wetlands by 2030 has been adopted (An et al., 2007). In the central Yangtze River basin, the plan focused on restoring floodplains through the removal of dikes that formed polders for rice production, especially around the two biggest lakes, Dongting and Poyang.

The environmental non-governmental organization World Wildlife Fund (WWF) saw an opportunity to work with the government from 1998 to achieve environmental and social co-benefits from the planned flood management measures. The Yangtze River basin is one of the most biodiverse freshwater eco-regions in the world, and WWF saw an opportunity for flood-adapted agriculture to enable sustainable development and biodiversity conservation.

Basinwide, around 2.4 million people were relocated from the floodplain to adjacent villages on higher land nearby, with state assistance for housing reconstruction, household biogas systems, and the establishment of new agricultural businesses with total government funding of RMB 10.1 billion for resettlement. The merits of relocating such a large number of people could be questioned, but in this case there are a number of reasons for considering a well-managed program to be appropriate. The people concerned had only occupied and developed these marginal floodplain lands in recent decades, lived in poverty and had poor access to services. In many cases they occupied lands without formal government approval and had constructed unauthorized flood levees. By occupying floodplains, these farm polders exacerbated the flood risk to other communities along the Yangtze River, were maintained at great expense to the farmers without government

support, and frequently failed in floods. As flood levees are up to 20 m high, failure can have catastrophic consequences. Indeed, a number of the relocations occurred after towns and villages that were inundated in floods in the 1990s were not drained and rebuilt. Further, the floodplains are infested with *schistosomiasis* and many residents were ill. Consequently relocation of these 2.4 million people to adjacent, higher ground served to reduce the flood danger to the residents concerned as well as to improve health and access to public services.

In a small number of locations the program was refined as WWF worked with government agencies and model villages to develop more effective approaches. For example, in one of the newly restored wetland nature reserves at Dongting Lake, WWF negotiated new by-laws between local people and government authorities to protect fish during breeding periods while allowing seasonal harvesting at other times. WWF also worked to develop the tourism industry as well as markets for premium agricultural products in order to diversify the local economy and increase income (WWF, 2003, Chen et al., 2003).

Supplementary Approach: Opening Sluice Gates

Further to the initial floodplain restoration under the "32 Character Policy," WWF worked with government authorities to test and then implement a second approach, namely, reopening sluice gates to restore floodplain wetlands and reconnect them to the river (Yu et al., 2009). This approach differs from the initial approach embraced by the Government because it retained the levee banks while restoring the wetlands cut off by these structures, resulting in more natural water flow, except when the gates need to be closed in a flood or drought. This second approach enabled additional storage of flood waters and the restoration of more, environmentally significant wetlands where governments were unwilling to remove levee banks because of the risk to adjacent population centers, e.g. near Wuhan. Renewed, variable water flows have improved water quality and enabled recovery of fish stocks and biodiversity. During floods, the floodplain lakes behind the retained dikes are used to store floodwaters within safe limits, before the gates are closed to prevent damage. Many of the restored floodplains and lakes have been designated as nature reserves by national, provincial and local governments (Yu et al., 2009; WWF, 2003).

The timeline differed between the two approaches. After the 1998 floods, the restoration of floodplains commenced immediately when some flooded polders were not drained. Active restoration of other polders was largely complete by 2002. The program for opening sluice gates saw the first lakes reconnected with the river in 2004 and the program continues to promote action at new sites (Yu et al., 2009).

Common Elements to Both Approaches

The "32 Character Policy" was implemented across the basin, especially through provincial governments and the Ministry of Water Resources, which has responsibility for flood management. The policy was the first time the government changed from an engineering-focused to an ecosystem-based approach to controlling floods. Considerable innovation occurred at the provincial and local levels, including when WWF partnered with these authorities at selected sites to ensure that local people benefitted from changed floodplain management. In Jiangxi Province, the cross-sectoral Mountain-River-Lake Office and Program were rejuvenated under the leadership of a charismatic

provincial governor to accelerate integrated management measures in the Poyang Lake tributary catchment (CCICED, 2010). In Hunan Province, provincial and county agencies partnered with WWF to restore floodplains and develop new, more sustainable livelihoods for the affected people (WWF, 2003). In Hubei Province, the provincial agencies partnered with WWF to reopen sluice gates, restore lakes and establish new livelihoods for local people. This approach was adopted by authorities in the Wuhan Municipal Government and Anhui Province (Yu et al., 2009). Considerable funding for this transition came from the Chinese government, with lesser amounts contributed by WWF and the provincial and local governments. Academic institutions made research contributions to these interventions.

At the national level, the project was coordinated by the State Council through the powerful National Development and Reform Commission and jointly implemented by sectoral agencies, including the Ministry of Water Resources, Ministry of Agriculture, State Forestry Administration and Environmental Protection Authority. The provincial and local governments were heavily involved in the implementation of the project. The authority provided by State Council leadership was essential to ensuring adequate cooperation between various government agencies.

WWF, supported by the Dutch aid agency DGIS and with corporate sponsorship from HSBC, and government agencies worked together to develop more sustainable and prosperous livelihoods in a number of locations, seeking to develop better ways of facilitating floodplain restoration. The central government played a crucial role in providing subsidies for farmers in transition, for example, to enable bamboo crops to be established and mature (Yu et al., 2009). This allowed them to remove aquaculture pens from the floodplain lakes; the resulting dilution of nutrients and restored water flows have dramatically improved water quality.

OUTCOMES

The outcomes can be described in terms of bio-physical risk reduction, environmental, and socio-economic benefits. In Hubei and Anhui provinces, the reconnection of 448 km^2 lake area to the Yangtze River enabled storage of 285 million m^3 of floodwaters. At Dongting Lake, an area of 1,700 km^2 with a floodwater retention capacity of 3.5 billion m^3 was restored (WWF, 2003). Similarly, at Poyang Lake, an area of 1,200 km^2 with 4.5 billion m^3 of floodwater retention capacity was restored (CCICED, 2010). The whole program in the Yangtze River basin has restored 2,900 km^2 of floodplains, which have added a floodwater retention capacity of 13 billion m^3. This storage capacity is crucial in safely holding floodwaters to reduce the height of the flood peak and risk of dike failure. This adaptation to flood risk has the advantage that it can be incrementally scaled up through further floodplain restoration if required as climate change unfolds.

Extensive environmental benefits have ensued, including substantial increases in fish stocks, return of extirpated species, and increased use of the floodplains by migratory water birds. Water quality in the floodplain lakes has substantially improved due to cessation of unsustainable aquacultural practices, restoration of aquatic vegetation, and dilution of pollutants (Yu et al., 2009). Large wetland areas have been designated as nature reserves (Yu et al., 2009, WWF, 2003).

Socio-economic resilience has increased in the communities where the government agencies and WWF worked together due to: a) economic diversification, b) higher incomes, c) reduced risks from flooding, and d) enhanced social capacities. Livelihoods were diversified from rice and unsustainable aquaculture into production of fruit and vegetables, wild-caught and floating cage fish, silk worms, bamboo shoots, lilies, and livestock. Subsidized biogas plants running on animal manure

now provide clean energy and organic fertilizer. Lower volume but higher quality agricultural produce has been certified as organic in many cases, and marketing has been organized into local urban centers to gain higher returns. Consequently the incomes of participants have increased greatly. WWF reports that at one polder, Xibanshanzhou on Dongting Lake, the income of local farmers had increased by 40% by 2003 (WWF, 2003). Where lakes have been reconnected and restored, wild fish catch increased by more than 15% within a year, and at two lakes the incomes of local people increased by around 30% (Yu et al., 2009).

These measures have been of particular benefit for women and children. Provision of biogas greatly reduced indoor pollution from wood and manure fires and improved health. Previously women would spend up to three hours per day looking for firewood, time that is now directed to new activities. The diversification of livelihood strategies has created many opportunities for women to take leading roles in running small businesses. The reduction of flooding risks has led to more outside investment which is creating more jobs for the local villagers. Further, higher incomes have enabled more families to send their children to school and to college.

The people who were relocated from the floodplains lived in poverty, ill-health and at great risk from floods. Chinese government intervention has seen the living conditions of the villagers improve on average with better health, housing, access to services, higher incomes and reduced flood risk. However, as in any large-scale program, not everyone has benefitted and complaints have been reported concerning instances of unfairness and corruption with the distribution of subsidies and other resources.

FACTORS THAT FACILITATED GOVERNMENT ACTION

A number of attributes of China's system of government enabled the adoption and implementation of the flood management reforms. The severity of the 1998 floods in the central Yangtze created a policy reform window that the central government seized (Huitema and Meijerink, 2009). The impracticality of building substantially higher levees was one factor behind the change of approach. More importantly, the ability of the academic and scientific community to provide sound and timely advice to China's technically literate leadership facilitated the change from a hard to a soft path to managing climatic variability. Further, the need for this reform arose at a time when the ecological impacts of China's economic development were beginning to cause great concern. This led to the adoption of the principles of the "Scientific Concept of Development" (in 2003) and "Harmonious Society" (in 2004) by the Central Committee of the Communist Party of China (GoC, 2007: 50). The concept of a harmonious society, which includes harmony between people and nature, was implemented in the 10th Five-Year Plan for National Economic and Social Development (2001-2005) (GoC, 2006).

China's centralized government planning system aided the adoption of this policy. First, the government establishes overarching objectives and targets through iterative five-year plans; responsibility for delivering these national targets is then assigned to each national agency and province. Further, the performance of the relevant officials is measured against these targets. This sort of iterative, target-driven approach can favor sustainability measures (Connor, 2004).

Major national planning and policy development is undertaken by a macro-economic agency, the cross-sectoral National Development and Reform Commission, which is chaired by the Vice-Premier,

overseen by a sub-committee of the State Council (cabinet) and which reports directly to the State Council. It was the NDRC that established the "32 Character Policy" in 1998 and then incorporated its measures into subsequent national five-year plans and the 2007 National Climate Change Programme. A related factor that enabled change is the growing wealth of China and ability of the central government to direct substantial resources to implements its policies, in this case, through transfer payments. Government capacity to reduce vulnerability on these floodplains is further enhanced by the adoption of a national development priority zoning policy in the last five-year plan, which classifies land into four categories (optimized, prioritized, limited development zones, and zones where exploitation is banned). This is anticipated to result in the designation of key floodplain regions as priorities for conservation.

These national policies may be interpreted and implemented slightly differently at the provincial and county scales. Without the intervention of the central government and WWF, the provincial governments undertook business-as-usual development of dikes to progressively convert floodplain ecosystems to agricultural use. In the case of the three key central Yangtze provinces – Hunan, Hubei and Jangxi – their governments were motivated to maximize the benefits for their people by implementing the floodplain restoration policies in a more innovative way as it attracted additional external funding from WWF and the central government, and maximized the socio-economic returns for the poorer rural communities living on these floodplains. In this case their partnerships with WWF in undertaking pilot projects to restore floodplain wetlands injected new ideas and additional funding, and provided a partner that could move easily across institutional boundaries to facilitate support (Yu et al., 2009; WWF, 2003). One aspect that accelerated implementation of these policies was the regular recognition through awards and media coverage, facilitated by WWF, of key officials and government agencies who took risks in trying the new 'soft path' flood management reforms.

The 'soft path' floodplain restoration measures implemented here have a number of attributes that aid effective climate change adaptation. Restoring floodplains can be undertaken iteratively as perceptions of risk and the adequacy of previous interventions are reassessed (Connor, 2004; Dovers and Hezri, 2010; Hallegatte, 2009). In addition, re-operating floodplain infrastructure in this way is relative inexpensive, quick to implement, and decentralized (Hallegatte, 2009).

BARRIERS TO ADOPTING AND ADVANCING THE INTERVENTION

While China's action to restore the central Yangtze floodplains is an overwhelming success, a number of barriers continue to hinder even better progress. At the national scale the NDRC and at the provincial scale the Mountain-River-Lake Office are excellent examples of cross-sectoral decision making; however, government departments usually do not collaborate on the ground (CCICED, 2010). This institutional rivalry is exacerbated by vague and overlapping sectoral laws and mandates. For instance, the law on fisheries enables fishing in wetland nature reserves whereas the law on nature reserves prohibits fishing (CCICED Task Force on Integrated River Basin Management, 2004). Another example is the conflicts that arise between the administration of water allocation and flood control by the Ministry of Water Resources and water quality by the Ministry for Environmental Protection (Wang et al., 2007).

China's system for setting targets and consequent performance indicators for officials and institutions is a powerful driver of change; however, the performance measures are often focused on economic development and quantity rather than quality, leading to an emphasis on exploitation of natural resources over environmental stewardship.

The limited options for citizens to hold government officials accountable further limit the implementation and enforcement of environmental laws (CCICED, 2010). Further, the payments to rural stewards of lands are usually lower for natural ecosystems compared to those lands being restored, and are limited to ten-year programs, so there is not yet security for payments for provision of ecosystem services (CCICED, 2010).

Understanding of the full range and value of ecosystem services is still limited in many institutions (CCICED, 2010). Despite the adoption of floodplain restoration in this case, when faced with a problem, many key provincial officials and national sectoral agencies opt first for the hard, engineering solutions that they understand, rather than considering soft options (Gleick, 2002, Opperman et al., 2009, CCICED, 2010). For example, the Jiangxi Provincial Government is currently proposing to maintain higher water levels in Poyang Lake by regulating the connection from the Yangtze River in order to overcome recent climate variability and seasonally reduced flows downstream of the Three Gorges Dam, rather than considering options such as more natural environmental flow releases from the dam (CCICED, 2010). China's National Climate Change Programme is another example of competing paradigms. The programme commits "to take more effort to convert farmland back into lake or river course, remove polder dykes for flood way ..." (GoC, 2007: 50). However it also commits to strengthening dike construction, inter-basin water transfers and hydropower expansion, among other climate change mitigation and adaptation measures (GoC, 2007). It is likely that the soft path approach to flood control was successful because the practical, physical limits of raising dikes had been reached , the economic, social and environmental costs were too high, and the risks from catastrophic breaks in dikes too severe. Some officials also saw benefits from the restored ecosystems. By contrast, there is less understanding of the ecological costs of hydropower and inter-basin transfers, or of the alternatives.

CONCLUSIONS AND LESSONS LEARNED

After nearly a millennium of efforts to control floods in the Yangtze River basin with dikes, polders and other hard engineering measures, the Chinese government – appreciating that the climate was likely to change – adopted a radically different approach after the disastrous 1998 floods. A soft path approach was adopted that saw several thousand square kilometers of floodplains restored to safely hold and slowly release peak floodwaters. This approach continues to be refined and was adopted as a key measure in China's 2007 National Climate Change Programme.

Restoring the floodplains was a 'no regrets' adaptation that is robust in managing climatic variability and change, and has extensive environmental and socio-economic co-benefits. In this case larger floods can be more safely managed. The environment has benefitted through improved water quality, recovery of flora and fauna, conservation of threatened species and designation of nature reserves. While 2.4 million people were relocated from the most flood-prone lands to adjacent, higher ground, their livelihoods and resilience have improved through diminution of the threat of flooding and *schistosomiasis*, economic diversification, higher incomes, and better access to services. Many of these people had already been displaced as floods engulfed their towns and villages. Given that climate change is anticipated to increase the frequency of severe floods, relocating the most vulnerable people out of harm's way was the most practical means of dealing with the greater flood risk.

A number of factors led to the success of the Chinese Government's policy for restoring the floodplains. The policy was a response to extreme

flooding in 1998, but is a proactive strategy that utilizes China's scientific capacity and cross-sectoral planning mechanisms, notably the NDRC, five-year plans and national development zoning. The policy builds on the government's principle of seeking "harmony" between people and nature and is implemented with substantial financial allocations. Barriers remain, including the ongoing challenge of achieving integrated implementation with competing and overlapping institutions, ongoing advocacy for hard, engineering solutions, and the need to hold local officials accountable for implementing national policies. Yet a strength of the Chinese approach is the iterative development and implementation of targeted policies that favors adaptive management.

The inclusion of ongoing floodplain restoration measures in the 2007 National Climate Change Programme, drawing on the lessons of the 1998 "32 Character Policy," illustrates how sound adaptive management and incremental implementation of 'no regrets' climate change adaptation measures can deliver considerable benefits for people and nature.

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