

REVIEW

China's transboundary waters: new paradigms for water and ecological security through applied ecology

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Summary

1. China is Asia's most important upstream riparian country, sharing 110 rivers and lakes with 18 downstream countries. Consequently, China's management of transboundary water resources must consider both environmental and geopolitical risks.

2. The major threats to and conflicts over international rivers in China revolve around biotic homogenisation due to the installation of transport links, water allocation, water pollution, alteration of natural flow patterns and disruption of fisheries due to the installation of hydro-power dams, and droughts and floods exacerbated by climate change. Because these problems have an international component, they fall under China's Peaceful Rise strategy, mandating that transboundary conflicts be resolved amicably as part of the overarching goal of increasing regional economic growth with as little conflict as possible.

3. Science-backed policy is more likely to result in long term, mutually agreeable solutions; the results of applied ecological research have already resulted in a number of mitigation measures, including setting operational thresholds to reduce the downstream impact of dams, designating protected areas along key river stretches where dams cannot be installed (one dam in a critical location has been cancelled), and the installation of terrestrial protected-area networks.

4. *Synthesis and applications.* Applied ecology will continue to play an important role in the diagnosis and resolution of environmental threats to China's transboundary waters. More importantly, applied ecology can inform the development of a transboundary environmental compensation mechanism and regional consultative mechanisms that support informed, cooperative decision-making for China and its riparian neighbours.

Key-words: Asian Mainland, climate change, geological issues, Himalayas, hydropower, Lancang-Mekong, Longitudinal Range-Gorge Region, Nu-Salween, Tibetan plateau, transboundary ecosystems

Introduction

Sharing 110 international rivers and lakes along its southwest, northwest, and northeast borders and being home to most of Asia's great rivers that flow into 18 downstream countries (Fig. 1), China is the most important upstream country for transboundary water and ecological security in Asia. This geographic reality makes the

transboundary water resources and corresponding environmental issues (termed 'eco-security' or 'eco-risk' issues in China) key components of China's international and regional relations. China's total transboundary water resources (TWR) of around 800 billion m³ in 2006 account for 31.72% of total runoff in China (Ministry of Water Resources of the People's Republic of China's 2007), most of which originate in the southwest of China, mainly from the 'Asian Water Towers' on the Tibetan-Qinghai Plateau. At present, these waters have not been heavily utilized and are still high quality – both rarities

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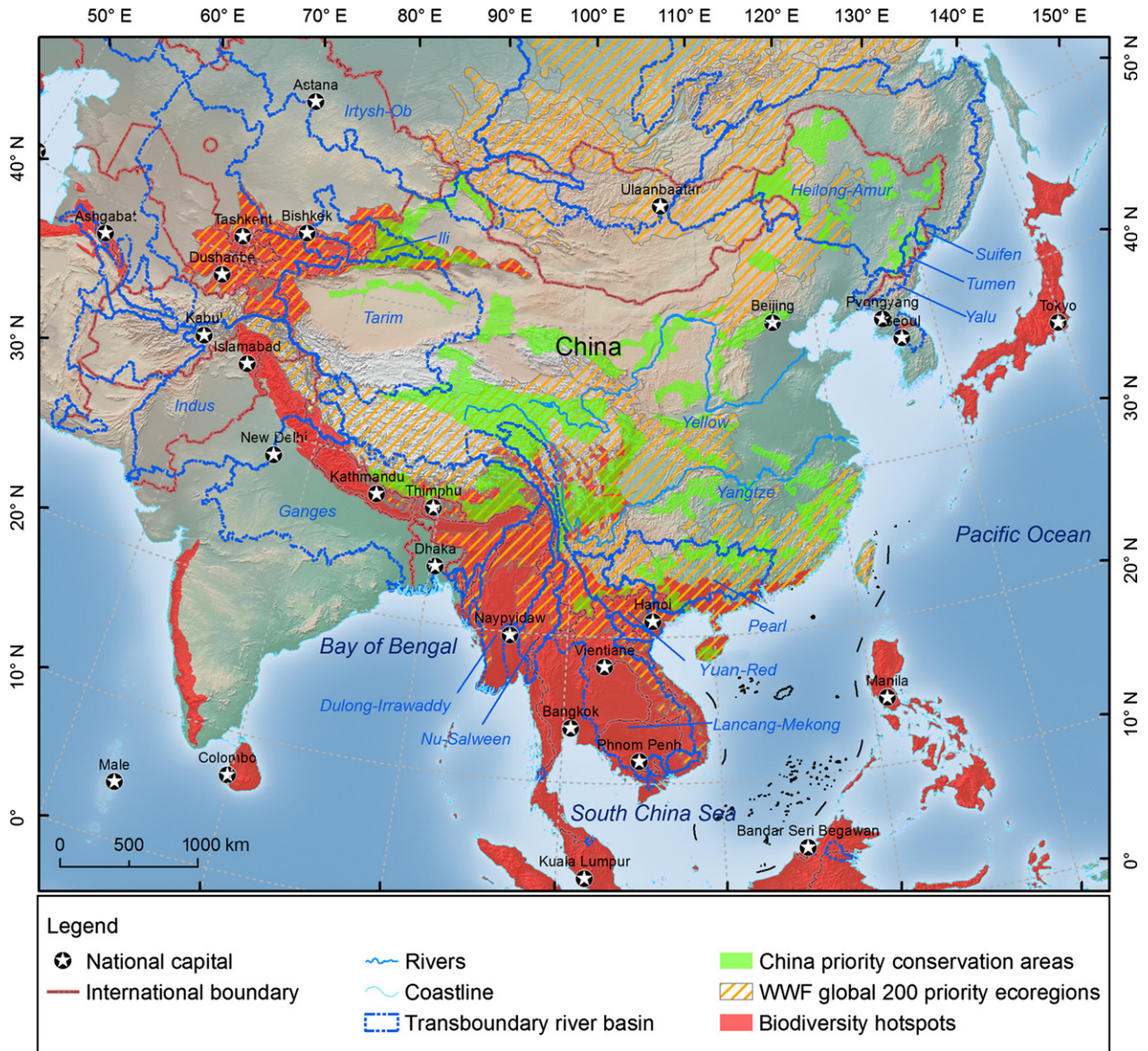


Fig. 1. Distributions of transboundary river basins and biodiversity conservation priorities on the borders of China and riparian countries.

given China’s economic growth and intensive use of natural resources. More importantly, these waters affect the lives of over two billion people in China as well as 10 downstream countries (Immerzeel, van Beek & Bierkens 2010).

Of the 17 international waters deemed to be at risk in the world (Wolf, Yoffe & Giordan 2003), the Ganges–Brahmaputra, Mekong, Ob (Ertis), Salween and Tumen originate in China. When factoring in ecological security, such as water pollution and biodiversity loss, the basins at risk grow to include the Ili, Irrawaddy, Red and Songhua rivers. As both China and its neighbours in Southeast Asia continue fuelling economic growth by exploiting natural resources, the massive and largely untapped TWR volumes in the upstream great rivers have become strategic resources for both China and its downstream countries.

China and its neighbouring countries share both water resources and transboundary ecosystems (Fig. 1). These ecosystems are usually located in remote mountainous areas, have survived mostly intact (Wu *et al.* 2011), and contain numerous priority conservation areas (Fig. 1). Among these are four biodiversity hotspots: the mountains of Central Asia and Southwest China, the Himalayas and the Indo-Burma region (Myers *et al.* 2000). Similarly, 11 of the 14 WWF Global 200 Priority Ecoregions (Olson & Dinerstein 2002) located in China and surrounding countries share some overlap with the international rivers region, and 17 of the 32 priority conservation areas listed in the new ‘China National Biodiversity Conservation Strategy and Action Plan’ are located either within or near the area (Ministry of Environment Protection of the People’s Republic of China’s

2011). One specific region of interest includes the four major waterways in Southwest China: the Yuan-Red (domestic name-foreign name), Lancang-Mekong, Nu-Salween, Dulong-Irrawaddy, plus the eastern part of Yarluzangbu-Brahmaputra and the upstream portion of the Yangtze, collectively named the 'Longitudinal Range-Gorge Region' (LRGR; Fig. 2; He *et al.* 2005). The LRGR's landscape of parallel ranges of high moun-

tains and deep gorges stretching roughly north to south from Southwest China to Southeast Asia, acts as corridors, vicariance barriers, and refugia for animal and plant species. The varied landscapes host many of the naturally occurring ecosystems known to exist in the Northern Hemisphere, making the LRGR one of the richest biodiversity regions in the world (Ou & Gao 2009).

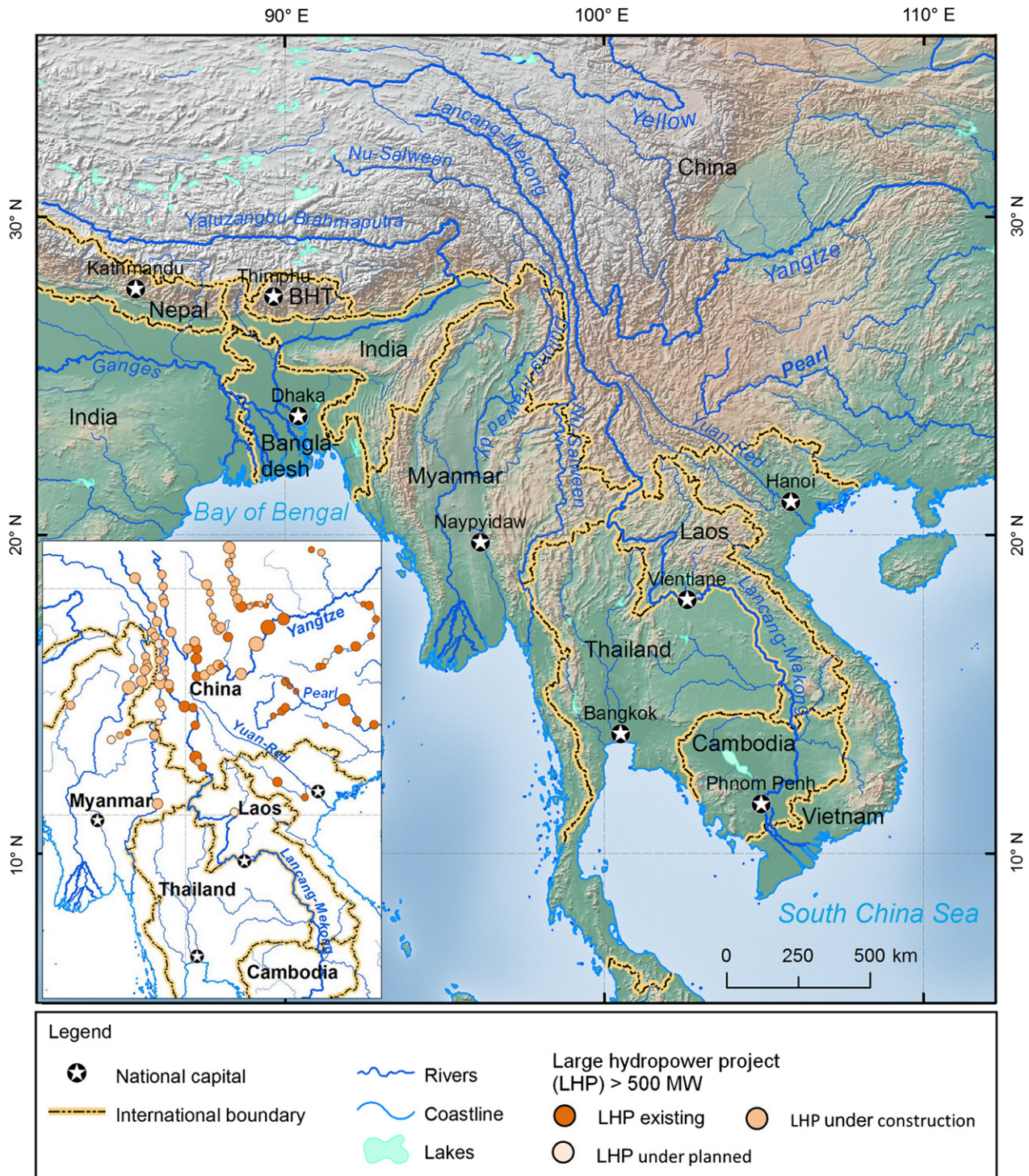


Fig. 2. Distributions of major rivers and large hydropower projects in the Longitudinal Range-Gorge Region.

The northern portion of the LRGR, known separately as the 'Three Parallel Rivers Region' (TPRR), is also a UNESCO World Heritage site located at the interchange of three bio-geographic realms: damp-temperate, dry, and damp-warm, which is a rare occurrence. Though covering only 0.83% of China's land surface, the TPRR contains 30% and 24.3% of the country's total recorded higher plant and vertebrate species, respectively (Ou & Gao 2009), meaning that the TPRR holds some of China's both best-preserved and most species-rich temperate ecosystems (The Nature Conservancy 2001).

China also possesses one of the world's largest and fastest growing hydropower infrastructures, making China's continued dam-building a key driver of transboundary hydro-ecological processes and environmental change (Thomas *et al.* 2013), and a geo-political controversy. As of 2011, China had 46 758 hydropower stations with a combined capacity of 333 million kW (Ministry of Water Resources & National Bureau of Statistics of the People's Republic of China's 2013). The international rivers account for nearly half of these hydroelectric resources, with transboundary watersheds continually being converted into 'power-sheds' for China and its downstream neighbours. For example, three of 13 state hydropower bases fall completely within international rivers in southwest and northeast China (Fig. 2). Similarly, in the LRGR, the mainstreams of Lancang (upper Mekong), Nu (upper Salween), and Jinsha (upper Yangtze), are scheduled to become state hydropower bases, with the Yarlungzangbu (upper Brahmaputra) potentially being an even larger hydropower base.

Collectively, all the issues facing the LRGR in particular, and transboundary water resources in general, have the potential for igniting conflict. We posit that science-backed research of the problems is more likely to result in long-term solutions that work for both China and its downstream neighbouring countries. In this study, we identify some challenges and gaps in applied ecology for the international rivers of China. We propose that applied ecology can guide a regulatory system aimed at reducing adverse transboundary impacts and preventing conflicts in the LRGR by facilitating informed decision-making for transboundary water and eco-security decisions between China and its neighbouring riparian countries.

Major transboundary water and eco-security issues of international rivers in China

GEO-COOPERATION AND ECO-SECURITY

Since the 1990s, China has facilitated an increasing number of 'geo-cooperation initiatives', namely, transboundary infrastructure projects such as highways, railways, ports, and gas and oil pipelines, which have unsurprisingly resulted in growing eco-security issues such as ecosystem fragmentation, species invasion and biodiversity loss in Southwest China and Southeast Asia, and environ-

mental pollution in Northwest China and the Central Asia. For example, geo-cooperation initiatives between China and the lower Mekong countries have resulted in greater transport volume and have created anthropogenic dispersal corridors, which have been implicated in documented increases in invasive species from the lower Mekong into the upper Mekong, including more than 70 plant species (Lu *et al.* 2006; Xu & Lu 2006).

WATER SHORTAGE AND POLLUTION

Asia is, unsurprisingly, the world's most populous and water-stressed continent (Global Water Partnership 2013). Underlying this general observation is a more subtle one. Since most of East Asia's transboundary water resources originate in China, China's reductions in water quality and increased demand for water and hydropower will invariably spill across its national borders and transform domestic environmental problems into geo-political conflicts (Feng & He 2009; Wouters & Chen 2013). Thus, even though China is seen as having control over these water resources, an already complex allocation problem becomes a political balancing act between the Chinese government's domestic and international standings, especially in volatile areas already suffering from water scarcity and geo-political conflict (Wolf 2009). For example, in the dry area from Northwest China to Central Asia, water is already an important strategic resource (Sun 2008; Yao, Zhou & Su 2013), and Kazakhstan has recently complained to China regarding Xinjiang Province's increased withdrawal of regional water resources to supply domestic agriculture, industry, and drinking water that has resulting in a marked decline in the Ili River's flow (Stone 2012).

Economic development in much of China and its neighbours has resulted in water pollution throughout the region, but the effects are most acutely seen in China (Liu & Zhang 2010). In northeast China, over 60% of river reaches are polluted (Feng & He 2009). For instance, on November 13, 2005, an explosion occurred in a petrochemical factory in Jilin City, resulting in hundreds of tons of benzene flowing from a factory into the Songhua River and causing severe transboundary pollution downstream, since the Songhua drains into the Amur River separating Russia and China. To date, over 130 organic contaminants have been detected in Songhua waters, including 44 toxins regulated by the US Environmental Protection Agency as priority pollutants on the basis of their toxicity, persistence, or other hazardous characteristics (Zhang *et al.* 2010). Fortunately (at least as far as regional conflict is concerned), much less pollution has occurred in the international rivers of western China than in eastern China's purely domestic rivers (Fig. 3). In Southwest China, especially in the LRGR, headwater composition is still mostly governed by natural processes (Xiang *et al.* 2009). However, for the middle and lower regions of the LRGR, water pollution is gradually

becoming a critical issue due to increased mining and damming. Recent research found that average concentrations of heavy metals in the sand beds of the upper Mekong (Zn 91.43 mg kg⁻¹ and Pb 41.85 mg kg⁻¹) are generally higher than those in the lower Mekong (Zn 68.17 mg kg⁻¹ and Pb 28.22 mg kg⁻¹); however, Cr average content in upper Mekong (42.19 mg kg⁻¹) is much lower than in the lower Mekong (418.86 mg kg⁻¹) (Fu *et al.* 2012), and further work is needed to explain why. The situation shows no signs of reversal in the immediate future. As more large mining sites are developed, more mega reservoirs start to store water, and the international oil and gas pipeline between China and Myanmar goes online, environmental pollution is likely to become a regular feature of the LRGR if no effective intergovernmental management regime is implemented.

HYDRO-ECOLOGICAL REGIME CHANGE

The most important and contentious hydro-ecological challenge is in the impact of large-scale hydropower development on river ecosystems. In the LRGR, mainstream hydropower development began in the early 1990s on the upper Mekong (the Lancang in China) before quickly expanding to other international rivers. These dams have received global attention due to their likely future impacts on the lower Mekong countries (Gayathri 2011; Ziv *et al.* 2012). However, studies of the current effects of hydropower installation on the region's hydro-ecologies are so far equivocal (Li, He & Feng 2011). One group of studies has suggested that China's dam development agenda on the Lancang has adversely affected downstream nations in terms of river ecosystem changes and potential for social

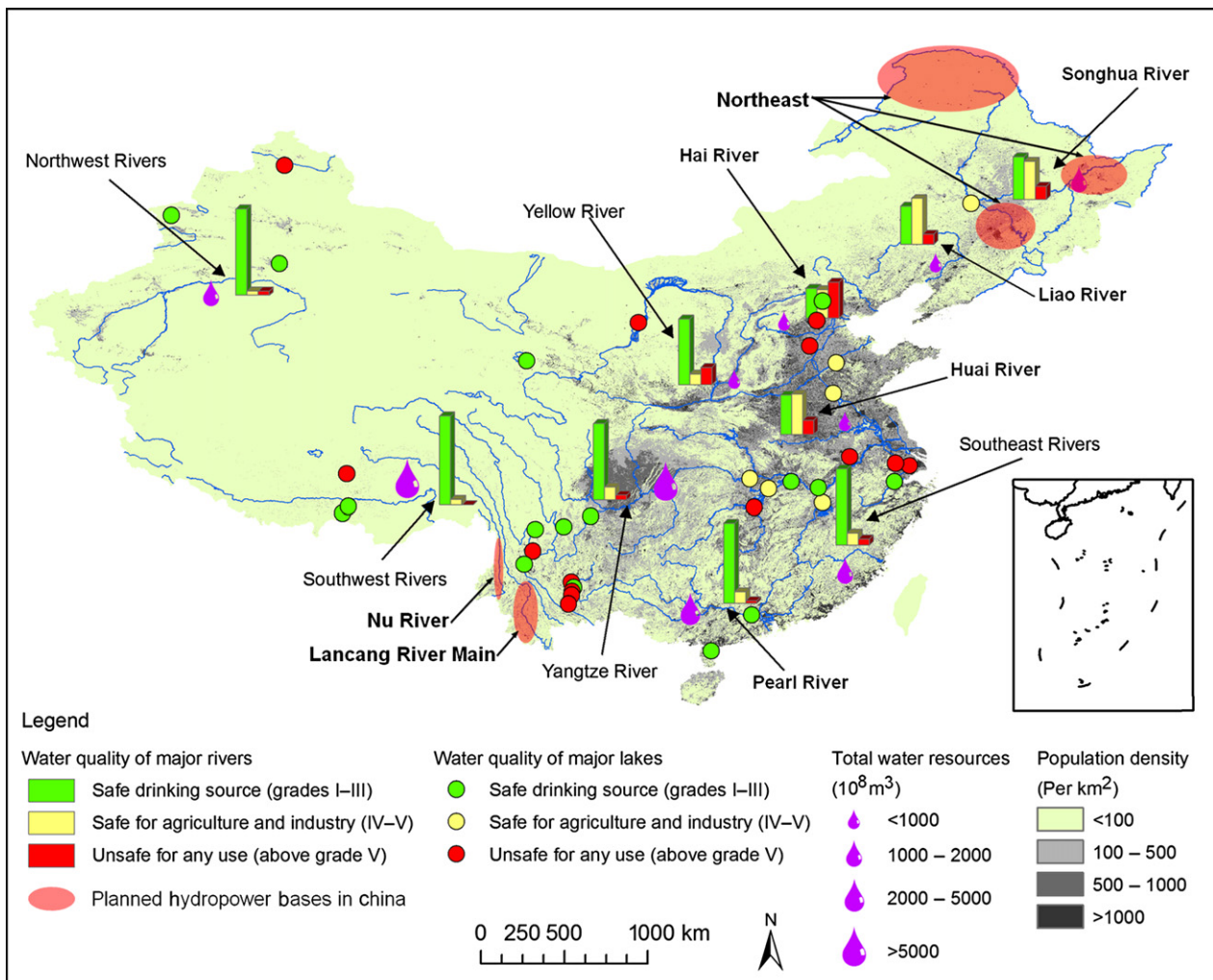


Fig. 3. Surface water quality in 10 river system regions and 26 major lakes circa 2011. Chinese Rivers are labelled with bars representing the distribution of water quality based on monitoring results in each river system, while water quality of major lakes is labelled with filled circles and total water resources is labelled with scale drop. In China, water quality is broken into five categories described as 'good' (Grades I, II, and III) or 'poor' (Grades IV and V or V+, which cannot support drinking). Grades represent official water quality classifications based on China's Surface Water Environmental Quality Standard as reported by the Ministry of Environmental Protection of the People's Republic of China. (Data sources: Ministry of Environmental Protection of the People's Republic of China. June 6, 2012. http://jcs.mep.gov.cn/hjzl/zkgb/2011zkgb/201206/t20120606_231040.htm. The Ministry of Water Resources of the People's Republic of China. December 17, 2012. http://www.mwr.gov.cn/zwzc/hygb/szygb/qgszygb/201212/t20121217_335297.html).

unrest (Liebman 2005; Hirsch 2006; Menniken 2007; Niccum 2008). Conversely, based on long-term hydrological record analysis, Campbell (2007) found that water quality, dry season flows, sediment loads, flooding and total fish catch in the lower Mekong basin – all issues previously identified by resource managers in the region as being high-priority – had not materialized into significant problems.

Despite differences of opinion, the general consensus is that even if the current impacts are limited, as more mega-dams are built in both the upper and lower Mekong, the cumulative effects will transform rivers by altering natural flow patterns and disrupting fisheries and other ecosystem services (Grumbine, Dore & Xu 2012; Ziv *et al.* 2012). In fact, in early 2013, the State Council of China announced China's 12th 5-Year Plan for State Energy Development, detailing 50 large dams slated for construction in China's portion of the LRGR (Fig. 2). These hydro-electric projects pose major threats to ecosystem services in the LRGR and downstream, with the potential to escalate environmental problems in China into regional conflicts over resources.

CLIMATE CHANGE AND HYDRO-METEOROLOGICAL DISASTERS

There is evidence that climate change is increasing snow and glacier melt in upstream regions in China which is affecting water availability in Central and South Asia (Mukhopadhyay 2012). Other reports suggest that more severe weather events will cause increasingly frequent eco-risks and hydro-meteorological disasters (Li *et al.* 2012). Recent examples of such risks, even if not necessarily caused by recent climate change, make clear the potential impacts of further global warming. For instance, the largest-ever landslide in Tibet, in total some $3.0 \times 10^8 \text{ m}^3$ of displaced debris, occurred on 9 April 2000 on the Yigong River, a tributary of the Yaluzangbu River, as a result of a sudden temperature increase. The landslide dammed the Yigong River and formed a vast reservoir of some 3.0 billion m^3 . On 10 June 2000, the water burst from the reservoir and created a huge flash-flood downstream with a maximum velocity of 11.0 m s^{-1} and a maximum discharge of $1.35 \times 10^5 \text{ m}^3 \text{ s}^{-1}$ as it entered India, where over 30 people died, 100 went missing and more than 50 000 were left homeless; in addition, 20 large bridges were washed away (Shrestha 2008). Conversely, the most severe drought in 80 years hit Yunnan from autumn 2009 to spring 2010, drying up 273 rivers and 413 small reservoirs, and giving rise to a series of transboundary disputes throughout the Mekong Subregion (Lv *et al.* 2012).

Towards transboundary water and ecological security in the Longitudinal Range-Gorge Region: an applied ecology approach

Proposed and on-going economic development programmes such as China's Western Development programme, the

geo-cooperative programmes of the Greater Mekong Subregional Economic Cooperation programme (GMS), and the China-ASEAN free trade zone ('10+1') are projected to raise eco-risks in the region to historically high levels (He *et al.* 2007).

Fortunately, regional cooperative programmes, which will be needed to manage and mitigate the negative effects of development, are an integral part of China's Peaceful Rise strategy. The strategy mandates that regional problems, including transboundary water and environmental issues, should be resolved amicably as part of the overarching goal of increasing regional economic integration and growth with as little conflict and antagonism as possible. This strategy in part explains why the Chinese government supports increased investment in scientific research in the problems that face China's transboundary water regions. The Peaceful Rise strategy pushes China to reach informed, long-term understanding of the complexity of the problems and to find meaningful and amicable solutions to water security issues.

Science-backed understanding is more likely to reach the solutions necessary to deal with the complex issues bound up with transboundary water resources. To date, the results of applied ecological research have been taken up by different levels of government and by state hydro-power companies in China, resulting in a number of mitigation measures, which we describe here.

TERRESTRIAL CONSERVATION PLANNING

The Chinese central government and the provincial governments have made great efforts since the 1950s to establish a network of protected areas in the LRGR, including national parks, which were recently introduced to China as an attempt to balance nature conservation and human livelihoods in the LRGR (Zhou & Grumbine 2011) and strictly protected nature reserves, which represent the bulk of protected-areas coverage (Wu *et al.* 2011). A series of large-scale payment programmes have also been implemented to protect and restore natural capital and ecosystem services, such as the Natural Forest Protection Programme, Forest Eco-Compensation Programme, Grassland Eco-Compensation Programme, Wetland Restoration Programme and the Grain-to-Green Programme (Liu *et al.* 2013). That said, to date, most protected areas in LRGR have been established opportunistically rather than as a result of systematic planning (Wu *et al.* 2011).

Between 1999 and 2000, the Yunnan Provincial Government collaborated with The Nature Conservancy (TNC) to identify priority areas for conservation in the TPRR, using the TNC's eco-regional assessment approach. This project presented two important reports (the Conservation and Development Action Plan for Northwest Yunnan and the Northwest Yunnan Eco-regional Conservation Assessment), which now serve as official guidelines for the establishment of a comprehensive protected area network and the optimal allocation of development activities in this

region (The Nature Conservancy 2001). This project was aided by ecological research using endangered and/or endemic plant species as representative conservation features to identify species diversity hotspots, thus providing an evidence-based framework in the LRGR (Ma *et al.* 2007; Zhang *et al.* 2012; Yang, Hu & Wu 2013).

To date, less attention has been paid to integrating conservation planning with development planning. As a start, we developed an integrated framework based on the systematic conservation planning approach (Margules & Pressey 2000; Ardon, Possingham & Klein 2010) to identify priority areas that simultaneously sustain natural ecosystems, culture and human livelihoods, using representative indicators of biodiversity, ecosystem services, geological landscapes, agricultural lands and cultural heritage. The goal of this framework was to help achieve the 'delicate balance' of China's domestic and international concerns for development of the region while following the Peaceful Rise strategy. We have used this framework to determine priority conservation areas along the Nujiang-Salween River that should be protected from development activities, such as hydropower development. This framework has been formally accepted by the state hydropower company, and now serves as a guide for their development planning. Expanding across the LRGR is the logical next step.

TRANSBOUNDARY WATER ALLOCATION AND UTILISATION PLANNING

The heart of most international water conflicts is the question of 'equitable' allocations (Wolf 1999). For the TWR, equitable allocation means sharing water benefits (Sakhiwe & Pieter 2004) to meet critical human needs and water quality objectives (Halliday 2010). Reviewing this issue, He (2000) arrived at two key conclusions in Lancang-Mekong: (i) transboundary water in the basin is plentiful, and water shortages never manifest at a basin-wide scale; and (ii) marked temporal and spatial differentiation offers an excellent basis for cooperative allocation and utilization between upstream and downstream countries. Predicated on these findings, He (2000) proposed multi-objective utilization (e.g. water supply, irrigation, hydropower and navigation) of water resources at the basin-wide level, with the core idea being that it is possible to resolve conflicts by sharing water-use-related benefits instead of focusing on water quantity allocation (Feng & He 2006).

In an attempt to reduce the downstream impact of upstream dams, operating thresholds, such as the maximum and minimum variation of water level, discharge and water temperature, have been set for all mainstream dams on the Lancang River so as to minimise damage from hydrological regime change in the lower Mekong. For example, water storage by the Xiaowan Dam (the largest reservoir in Lancang River basin) was scheduled to start filling mainly in the rainy season to

minimize downstream impact, while also ensuring that outflow always exceeded $728 \text{ m}^3 \text{ s}^{-1}$ to meet downstream water demand for navigation, irrigation, domestic water supply, and to be as consistent with the natural flow patterns as possible (ESCIR 2009). Similar principles have been applied to the Nuozadu dam, which has a larger storage capacity, downstream of Xiaowan. To our knowledge, there are no transboundary water disputes have arisen directly related to these storage operations.

PROTECTION OF AQUATIC HABITAT DIVERSITY

Despite the ongoing mitigation efforts, the unfortunate reality is that dams still pose major threats to freshwater species diversity and abundance, most importantly because dams can cut off adult fish populations from spawning sites, leading to declines in fish diversity and increases in biotic homogenization (Peter 2012; Ziv *et al.* 2012). This threat is particularly acute in the Southwest of China, which hosts over 40% of China's 920 recorded freshwater fish species (Kang *et al.* 2013).

In the Xiaowan dam reservoir, fish species richness declined from 13 species (nine native) before the dam impoundment in 2008 to 10 species (and only one native) after impoundment in 2011 (Li *et al.* 2013). In the lower reaches of the upper Mekong, the flagship giant catfish *Pangasianodon gigas* and the migrant species *Pangasius* sp. have not been harvested for many years (Yang, Chen & Chen 2007), apparently due to migration paths being blocked and the hydrological regime being altered, concurrent with a drastic change in fish fauna that is now dominated by introduced species (Kang *et al.* 2009).

The most robust and feasible approach to preserving indigenous fish habitat is to install riverine protected areas. In our research conducted between 1993 and 2006, we concluded that the key fish habitats to protect are the Buyuan and Nanna rivers in the upper Mekong and the Lixian and Nanxi Rivers in the upper Red (He, Feng & Hu 2009). A further study identified the Buyuan River as a key migration corridor between the upper and lower Mekong (Fig. 2; He, Feng & Hu 2009). In part due to this finding, in 2010 the central government cancelled the Mengsong Dam project (China Daily 2012). We are currently identifying key habitats and migration corridors along the Lancang-Mekong under the auspices of an integrated plan for fish ecosystem health, supported by two large grants from the National Key Technologies R&D Program of China, 2011BAC09B07 and 2013BAB06B03 (2011–16).

TRANSBOUNDARY 'BIO-ISOLATION' AGAINST INVASIVE SPECIES

The valleys of the LRGR serve as dispersal corridors between the upstream and downstream Greater Mekong Subregion (GMS) countries, allowing for both natural

migration and invasive species. For instance, the LRGR is the key gateway through which numerous species of fruit flies from lower GMS countries invade China (Ye 2011): six non-native species in the China-Myanmar boundary region; 64 in the China-Laos-Myanmar border region; and 21 in the China-Laos-Vietnam border region. There are several complementary countermeasures that should be explored to prevent further invasions (known as 'bio-isolation for transboundary eco-security' in China): (i) establishment of transboundary nature reserves for biodiversity conservation; (ii) construction of artificial forest zones to deter transboundary species invasion; (iii) an eco-security monitoring programme; and (iv) development of transboundary ecological compensation mechanism (He, Feng & Hu 2009).

Prospects for applied ecology on transboundary issues in China

The management of water and eco-security issues must consider a multitude of drivers, including, among others, climate change, land use and coverage change, cascade hydropower dams, road systems, international navigation, sloping land cultivation, and mineral exploration. Moreover, China's unique position as the primary upstream country in East Asia forces it to address these issues on both domestic and international fronts, adding political sensitivities to an already complex set of biophysical environments, economies, cultures, and legal and political systems.

At the most fundamental level, we need more joint scientific research projects and information sharing to head off and mitigate transboundary water and eco-security disputes, especially in the GMS. Such cooperation can build on existing treaty practices and rules of international law but must also develop novel mechanisms (Wouters & Chen 2013) because the politically sensitive nature of 'geo-hydro-politics' discourages information sharing between China and its neighbours. Despite these problems, China has signed up to series of agreements with neighbouring countries related to flooding information sharing, water quality monitoring and environmental conservation. However, there is still no basin-wide plan for managing transboundary water resources (He & Feng 2013).

There are also major information gaps, even to the extent that the word 'gap' implies the opposite of the reality, since only the Lancang-Mekong river basin has been the subject of basin-wide research, while China's other transboundary waters (even very important rivers such as the Yalongzangbo-Brahmaputra, the Yili and the Amur) have not been the subject of any basin-wide research efforts. Some attempts are currently being conducted to improve these deficiencies, such as the Chinese government's new mandate that 'new projects in transboundary rivers must go through scientific planning and study, with the consideration of the interests of both downstream and upstream riparian countries' (Ministry of Foreign Affairs of the People's Republic of China's 2013). The degree to

which this mandate has teeth is another question altogether, but the statement itself is a clear call for integrated transboundary water research and highlights another gap, which is that applied ecology in transboundary water and eco-security is underdeveloped relative to the disciplines of hydrology, geography and meteorology.

Moving forward, we see four key challenges for transboundary water management in China and its downstream countries. Firstly, we need more quantitative and efficient assessments of the effects of dams and their downstream impacts if we are to develop mechanisms to maintain the integrity of these riverine ecosystems. Secondly, we need better understanding of species invasions and potential heavy-metal pollution in the LRGR, focusing on the Lancang-Mekong, Yuan-Red, Nu-Salween and Irrawaddy rivers. Third, we need to learn how to coordinate and manage existing, separate protected areas along the border zones into effective transboundary networks that can assist in controlling invasions of exotic ecosystem-altering species along watercourses and international highways, ideally cooperating internationally. Fourthly, we propose a new, integrated model of water allocation that has the flexibility to invoke transboundary environmental compensation mechanisms, aligned with international law, which will help to resolve conflicts over water allocation and mobilise relevant national laws to ensure water equity and eco-security. Meeting these transboundary challenges will require transdisciplinary and international cooperation across hydrology, geography, and meteorology, hydraulic engineering, risk management, politics, policy and law.

Furthermore, in and around China, we propose that applied ecological research on river systems should coalesce around two key areas: (i) water allocation, management, and ecosystem sustainability between Northwest China and Central Asia, linked to the biggest, driest, and most rapidly degrading area in Asia, focusing on the Yili and Ob rivers; and (ii) extreme hydro-meteorological disasters (flash flooding, regional droughts and lake water level rise), especially in the Hindu Kush Himalayas between the Tibetan plateau of China and South Asia, focusing on Yalongzangbo-Brahmaputra river.

In the final analysis, as more and more dams are constructed on rivers shared by China and its downstream neighbours, transboundary issues are bound to multiply at an ever faster rate. To slow the damage and begin reversing the negative effects – environmental, political, and economic – applied ecology can play an important role, not only in diagnosing problems and designing solutions but also in providing a firm scientific basis on which constructive dialogue can take place.

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