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PERSPECTIVE

Managing the Three-Rivers Headwater Region, China: From Ecological Engineering to Social Engineering

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Abstract The three-rivers headwater region (THRHR) of Qinghai province, China plays a key role as source of fresh water and ecosystem services for central and eastern China. Global warming and human activities in the THRHR have threatened the ecosystem since the 1980s. Therefore, the Chinese government has included managing of the THRHR in the national strategy since 2003. The State Integrated Test and Demonstration Region of the THRHR highlights the connection with social engineering (focus on improving people's livelihood and well-being) in managing nature reserves. Based on this program, this perspective attempts a holistic analysis of the strategic role of the THRHR, requirements for change, indices of change, and approaches to change. Long-term success of managing nature reserves requires effective combination of ecological conservation, economic development, and social progress. Thus, the philosophy of social engineering should be employed as a strategy to manage the THRHR.

Keywords The three-rivers headwater · National governance · Ecological engineering · Social engineering · Strategic transformation

INTRODUCTION

The three-rivers headwater region (THRHR) of Qinghai province is the source of the Yangtze River, Yellow River, and Lancang River. The THRHR is an important supply of fresh water resources in China. It is also an ecological security shelter for the Qinghai-Tibetan Plateau and is of special importance for maintaining ecological security and sustainable development for China and Southeast Asia (Zhao 2009). Ecological security is defined here as the goal of stakeholders to create a condition where the physical surroundings of a community provide for the needs of its inhabitants without diminishing its natural stock (Timoshenko 1989; Rogers 1997). There is evidence that warming of the atmosphere and human activities in the THRHR has weakened the structure and function of ecosystems since the 1980s. The well-being of local residents, ecological security, and sustainable development in the downstream catchments, as well as a large part of southeast Asia, are threatened by habitat loss, fragmentation, and ecosystem degradation of the THRHR (Xiao et al. 2010; Zhang et al. 2012). Therefore, the THRHR Nature Reserve was established in 2000, and approved by the State Council in 2003 as a National Nature Reserve. The "General Plan for Ecological Protection and Restoration in the THRHR" (EPRP) was approved by the State Council in 2005, and 7.5×10^9 Yuan (approximately 1.19×10^9 US$) are earmarked for ecosystem protection and restoration projects in the region. Although the main objectives have been achieved in the EPRP project, some researchers argued for the need for a fundamental shift in the way the THRHR nature reserve is managed due to the threats posed to it by increasing pressures from a changing climate and unsustainable demands of people's livelihood. To fundamentally curb the degradation of ecosystems, develop the mechanisms for ecosystem protection, and improve local people's livelihood, the State Council approved the implementation of the "State Integrated Test and Demonstration Region (SITDR) of the THRHR" in 2011. The transfer from the EPRP to the SITDR implies not only the strengthening, but also the transformation of the national strategy for ecological conservation in the THRHR. It is well known that National Nature Reserves are a key selection of nationally important sites of special scientific interest, managed with the prime objective of nature conservation.

Recasting the relationship between conservation and development, merging environment and economics in decision making, is always the crucial issue of sustainable nature reserve management (Romero et al. 2012). If the target of the EPRP is mainly focused on the ecological protection and restoration (e.g., focus on ecological engineering), the SITDR is increasing the emphasis placed on improving local resident's livelihood and welfare (e.g., focus on social engineering). To ensure consistency with early literature, the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both is referred to as "ecological engineering" (Mitsch and Jorgensen 1989). Restorations of degraded ecosystems, as well as the development of new sustainable ecosystems, are typically seen as two main goals of ecological engineering (Mitsch and Jorgensen 1989). The EPRP has included the thoughts and actions of economic development but it has little consideration of livelihood improvements (*min-sheng*) and people-oriented development philosophy. In fact, in recent years, the satisfaction of human needs and aspirations is obviously an objective of decision making in China. The "Outline of the Twelfth Five-Year (2011–2015) Program for National Economic and Social Development of the People's Republic of China" explicitly states that China will "safeguard and improve people's livelihood as the starting point and objectives for accelerating the transformation of economic growth pattern" (Xinhua 2011). At the same time, China pledges to improve people's livelihood with intensified legislation (IOSC 2011). These findings have emphasized the importance of the strategic transformation in nature conservation. Therefore, in this paper, the concept of social engineering can be understood mainly as the "people's livelihood program" (*min-sheng–gong-cheng*). In other words, social engineering refers to satisfying the new expectations of all nationalities for a better life, stressing the "people-oriented" philosophy of development, and making security and improvement in people's livelihood.

What accounts for the shift of national strategy from ecological engineering to social engineering? Is the proposed social engineering strategy and action agenda adequate to tackle environmental change and sustainable development challenges in this region? To answer the above questions, the main purpose of this paper tries to synthesize the characteristics of strategic transformation for managing the THRHR, and to provide several lessons for developing effective policies for other countries or regions in the world. The following section of this paper presents the strategic role of the THRHR and the requirements of strategic transformation for managing the THRHR. The proceeding section will describe the indication of, and approaches to, managing the THRHR.

Strategic Role of the THRHR

The integrated test area of the THRHR includes four Tibetan Autonomous Prefectures and 21 counties in Yushu, Golog, Huangnan, Hainan, and Tanggula townships of Golmud City (Table 1). It borders the Tibet Autonomous Region on the west and Sichuan Province on the east, with a total area of 394 650 km^2, which occupies 54.5 % of the total area of Qinghai province (Fig. 1).

The Water Tower of China and Asia

The Qinghai-Tibetan Plateau has long been described as "the Roof of the World" and the third polar region. Several great rivers such as the Yellow River, the Yangtze River, the Lancang River (Mekong), the YarlongTsangpo (Brahmaputra), the Indus, and the Ganges all originate in this region. The THRHR lies in the hinterland of the Qinghai-Tibetan Plateau, the headwater region of many important rivers, and thus plays an important role in the hydrological cycle of rivers. The region provides 25 % of the water flowing down the Yangtze, 49 % of the water in the Yellow River, and 15 % of the Lancang River water (Zhang et al. 2012; Luo and Yang 2011; Zhao and Zhou 2005).

The Concentrated Area of High-Altitude Wetlands

The THRHR, with an average elevation above 4000 m (Fig. 2), has 16 543 lakes with an area of 2354 km^2. The total area of high-altitude wetlands has been reported to be around 1100 km^2 (Chang et al. 2011). It is also the largest, highest, and most diversified wetland in the world. Due to the vast area of the wetlands, they are of great environmental, ecological, and socio-economic importance. They act as "the kidney of the earth" in improving water and soil conservation, maintaining biodiversity, and a high quality ecological balance.

The Gene Banks of Alpine Bio-resources

The THRHR is characterized by a cold and dry climate. Because of the harsh alpine environment, the THRHR therefore offers a unique setting for wildlife species. According to the literature (Liu et al. 2005), it is home to 2238 species of vascular plants, accounting for 81 and 8 % of the total amount of Qinghai and China, respectively. Among 2238 species of vascular plants, there are more than 40 rare and endangered plants, more than 1000 Chinese endemic species, and 705 endemic species of the Qinghai-Tibetan Plateau. The land vertebrates comprise a number of 370 species, approximately accounting for 47 and 11 % of the total vertebrate species of Qinghai and China, respectively. There are 16 species listed as first-class

Table 1 Major economic and social indicator in the three-rivers headwater region of Qinghai Province (2009)

Name of headwater	Administrative region	Population density (person/km^2)	Share of rural population (%)	Share of animal husbandry in primary industry (%)	Share of primary industry in GDP (%)	Income per capita of rural residents (Yuan/person)	Rural Engel coefficient (%)
Yangtze River	Yushu	5.4	78.9	89.3	66.4	2630	81.6
	Chengdu	3.8	91.1	90.2	57.8	2033	80.7
	Zhiduo	0.4	83.9	88.9	74.4	2695	81.0
	Qumalai	0.6	86.2	78.8	64.3	2908.8	54.7
	Tanggula	0.04	68.4	92.2		4574 (2005)	–
Yellow River	Maqin	3.4	64.4	80.4	18.6	3872.1	53.7
	Banma	4.2	80.8	75.6	45.1	2244	57.0
	Gande	4.0	92.9	87.1	54.1	1903.4	51.3
	Dari	2.1	74.2	67.7	40.9	1721.2	53.8
	Jiuzhi	2.5	86.4	75.7	53.8	2171.0	52.0
	Maduo	0.5	84.6	93.8	50.4	2370.7	57.7
	Tongren	26.6	71.3	42.4	22.9	3035.4	44.3
	Zeku	9.6	92.5	90.3	64.2	2012.9	74.4
	Jianzha	25.8	78.6	61.7	9.5	2361.4	30.8
	Henan	5.1	86.1	89.8	64.5	3470.2	35.5
	Gonghe	7.8	65.2	81.3	18.3	4069.8	40.4
	Tongde	11.4	84.2	83.1	55.6	4009.0	50.9
	Guide	30.3	79.2	41.9	10.7	3540.4	48.7
	Xinghai	5.6	88.2	71.4	32.7	4086.6	48.8
	Guinan	11.3	74.7	63.6	51.3	3426.6	49.1
Lancang River	Zaduo	1.6	90.6	45.7	78.7	2521	79.6
	Nangqian	7.3	82.8	78.4	70.4	1823.6	85.3
	THRHR	3.1	79.9	75.8	36.2	2932.3	60.9
	Qinghai	7.7	58.1	72.3	9.9	3346.15	38.1
	Mainland China	142.8	49.2	54.9	10.6	5153.2	41.0

Note: Engel coefficient is the proportion of total family income spent on food (e.g., food consumption expenditure/total consumption expenditure), in other words, the income elasticity of demand of food is between 0 and 1

national protected animals of China in this area, including Tibetan antelope (*Pantholopshodgsoni*), Wild yak (*Poephagusmutus*), Tibetan wild ass (*Equus kiang*), Snow leopard (*Panthera uncial*), Leopard (*Pantherapardus*), White-lipped deer (*Cervusalbirostris*), Black-necked crane (*Grusnigricollis*), Golden eagle (*Aquila chrysaetosdaphanea*), Pallas's fish-eagle (*Haliaeetusleucoryphus*). 53 species are listed as second-class national protected animals of China.

One of the Most Vulnerable Ecosystems

The Qinghai-Tibetan Plateau not only has an important influence on the atmospheric circulation of the northern hemisphere, but also directly affected the eco-environment evolution of China (Dianfa et al. 2000). In a cold and dry context, the prevailing alpine meadow and alpine steppe have a short growth-period and low productivity. The alpine ecosystem is very vulnerable to strong freeze–thaw cycles due to its simple structure, slow energy flow, inefficient recycling, poor resistance to damage, and low capacity for rehabilitation (Dong et al. 2002). At the same time, the THRHR experiences a variety of natural adversities throughout the year such as snowstorms, drought, flooding, hail, and high densities of rodents. Many studies have indicated that burrowing or fossorial rodents, such as plateau zokors (*Myospalaxbaileyi*), voles (*Microtus* spp.), and jerboas (*Allactaga* spp.) have exerted significant negative impacts on trophic dynamics and ecosystem services (Harris 2010). Similarly, according to a survey conducted by Jin et al. (2009), the degrading or degraded permafrost has improved the physical conditions for rodent activities such as burrowing. As a result, rodents invade in larger numbers and reproduce at a more rapid rate, causing further damage to pastoral lands.

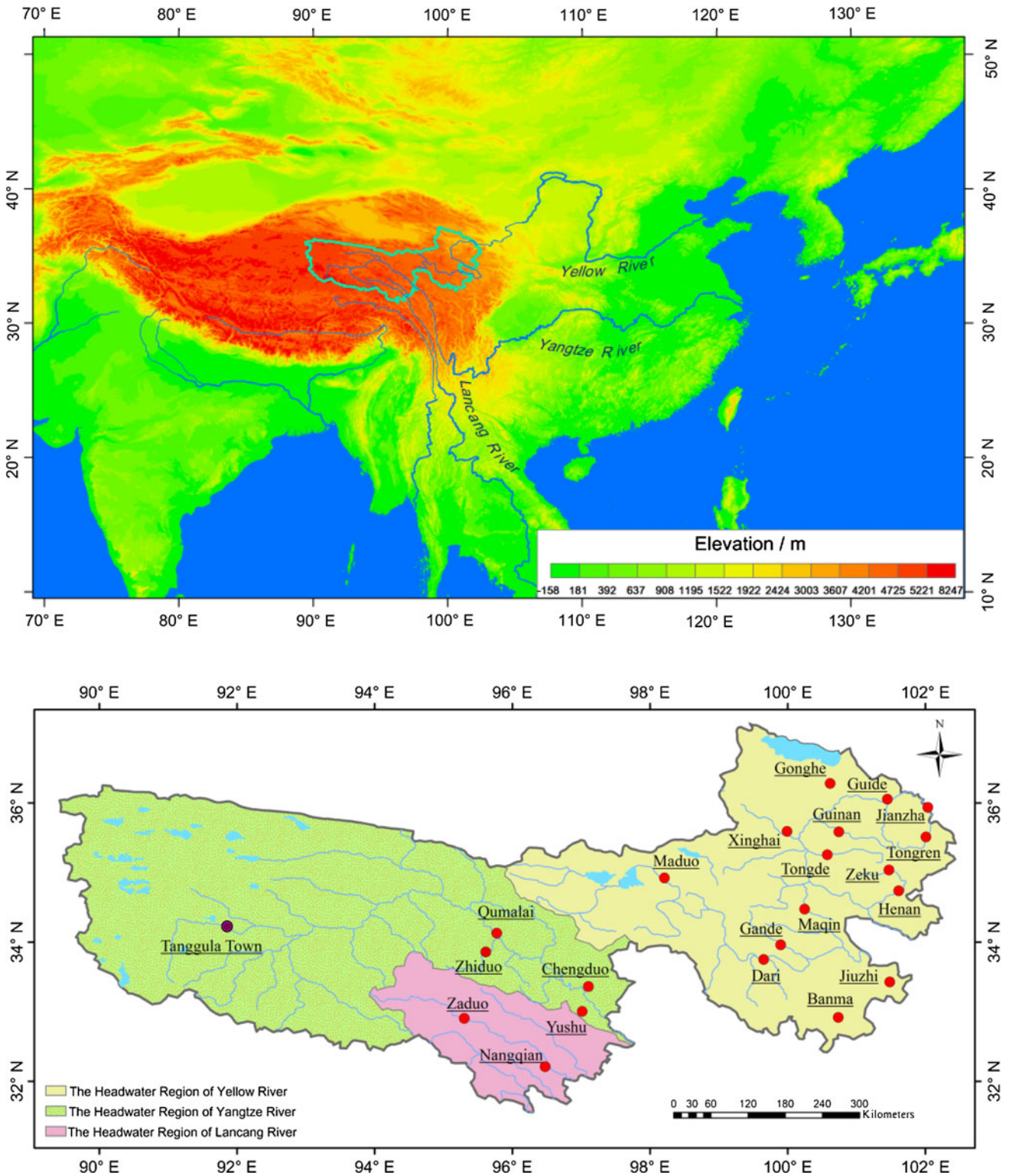

Fig. 1 The location of the three-rivers headwater region of Qinghai Province

The Crucial Area of Poverty Alleviation

The THRHR is home to over 1 210 000 people with extremely sparse populations of nomadic Tibetans (e.g., 3.1 people per km^2), and most are ethnic Tibetan herders who rely almost exclusively on livestock as their main source of income. Table 1 indicates that the value-added of animal husbandry occupies 75.8 % of the total value-added

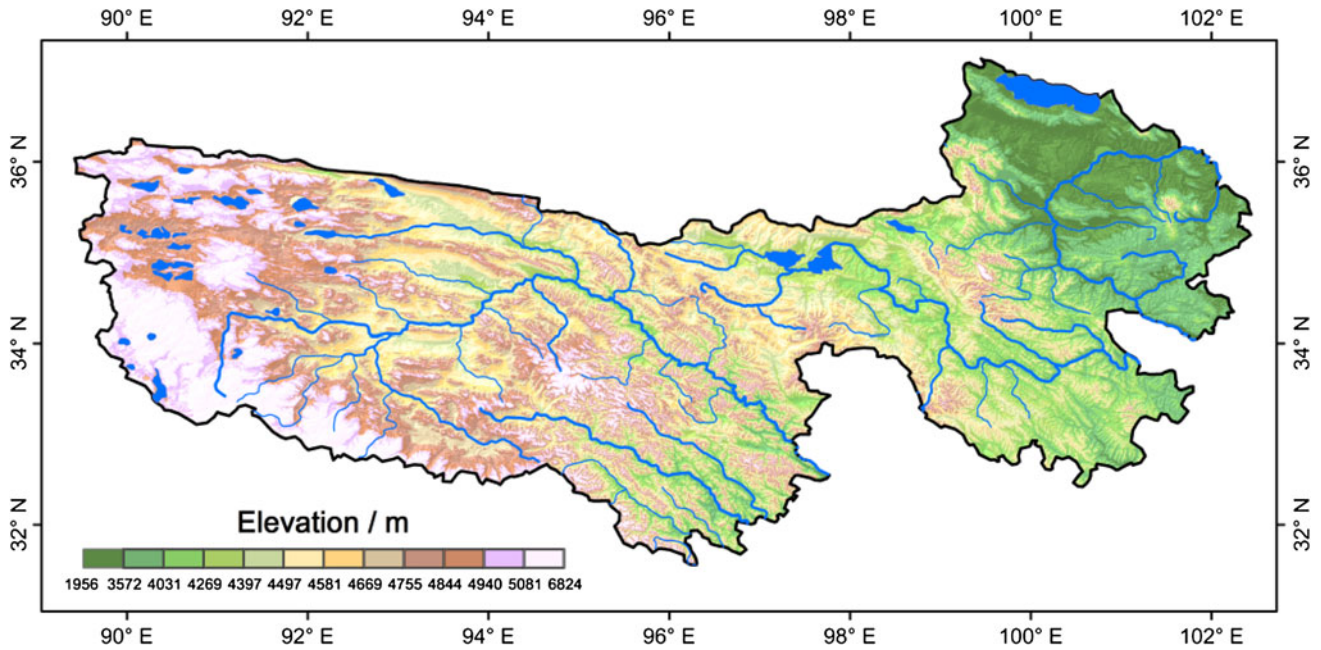

Fig. 2 Landform of the three-rivers headwater region of Qinghai Province

of the primary industry, and occupies nearly 36.2 % of the total Gross Domestic Product of the whole region (Statistical Bureau of Qinghai Province 2011). As a result of its remoteness, the urbanization rate is less than 20 %, and the income per capita for the rural households is 2932.2 Yuan RMB (approximately 465.4 US$), around 87.6 %, and 56.9 % as high as the Qinghai and national average levels. The Engel's coefficient, which is defined as the percentage of income spent on food to total income of a household, is as high as 60.9 % (e.g., 1.6 and 1.5 times that of Qinghai and the national average). Engel's coefficient similarly states that lower income households spend a greater proportion of their available income on food than middle- or higher-income households. As a household's income increases, the percentage of income spent on food decreases while the proportion spent on other goods (such as luxury goods) increases. As can be seen from Table 1, the higher Engel's coefficient further illustrates lower living levels and living quality (Statistical Bureau of Qinghai Province 2011), and higher incidence of poverty in the THRHR (Fang et al. 2011b).

Necessities of Strategic Transformation for Managing THRHR

For Further Strengthening of the Eco-protection Strategy

The main target of the EPRP launched in 2005 is to conserve and rehabilitate fragile ecosystems through ecological migration (e.g., a government-initiated, permanent resettlement of herders and farmers away from fragile ecological environments and into new or existing settlements outside of ecologically vulnerable regions), grazing bans, wetland protection, and harnessing degraded grassland programs. Since the implementation of the EPRP, the capacity of soil and water conservation practice has been increased and grassland deterioration has slowed down significantly. At the same time, the EPRP has contributed greatly to improving the production and living conditions of farmers and herdsmen through training, grazing relocation, ecological migration, and industrial development activities, etc. However, due to the twofold impacts of climate change and human activities on the ecosystem, the general trend of ecosystem degradation has not been fully controlled. As investigated by Fang et al. (2011b), the area of permafrost has shrunk 18 900 km^2, and the area of unstable permafrost has extended 15 000 km^2 since the 1980s in the source regions of the Yangtze and Yellow Rivers with warmer temperatures. From the various studies that have been done on permafrost, there has emerged evidence for permafrost degradation having significant negative effects on alpine ecosystems and grassland productivity (Fang et al. 2011b). Fang et al. (2011b) further estimated the dynamic change of theoretical livestock carrying capacity, and the result indicated that the theoretical livestock carrying capacity has dropped 11 % in the source regions of the Yangtze and Yellow Rivers during the 1980s–2000s, mainly due to the spatial change of frozen soil. It is noted that there is still a long way to go in grazing removal, rodent control, black beach (e.g., black-

soil-beach is bare soil formed after degradation of alpine meadows, in other words, the soils are generally bare in winter and the sparsely covered land has only annual weeds or poisonous plants in summer) management (Shang and Long 2005; Ma et al. 2008), desertification mitigation, and biodiversity conservation (Fang et al. 2010, 2011b, 2012).

For Further Improving the Living Standards of Pastoralists

In the THRHR, animal husbandry occupies an important position in the agricultural economy. The revenue of livestock production and sale accounts for 80 % of the total household income, with about 73 % of the population deriving their livelihood from livestock production (Fang et al. 2011a). Even though the "Returning Grazing Land to Grassland Program"(launched in 2004, with a total investment of 14.3×10^9 Yuan RMB, and including Inner Mongolia, Xinjiang, Tibet, Qinghai, Sichuan, Gansu, Ningxia, and Yunnan) is of great strategic significance to the restoration of the grassland ecosystem, due to grazing bans and the loss of household's income, local herdsmen are receiving different kinds of subsidies such as artificial grass subsidy of 2400 Yuan RMB, fenced pasture subsidy of 300 Yuan RMB, grass seed subsidy of 300 Yuan RMB, grazing bans subsidy of 90 Yuan RMB per hectare of grassland per year, and livestock shelter construction subsidy of 3000 Yuan RMB per household, etc. However, this modest government subsidy cannot cover daily expenditures for a whole household. In addition, in the THRHR, the income per capita gaps between pastoralist and national, pastoralist and Qinghai averages of rural residents are widening from 1.8 times in 2005 to 2.4 times in 2010, and from 1.2 times in 2005 to 2.4 times in 2010 (Shi et al. 2011). Therefore, great efforts should be placed in narrowing the income gaps. The new national development guidelines for building a Xiao Kang (well-off) Society were approved by the 16th National Congress of the Communist Party of China, where the concept of the Xiao Kang Society was broadened to denote not only material comfort, but harmonious development in all aspects. In other words, balanced development has thus become a top priority of the government of China (NCCPC 2002).

For Smooth Solution of Eco-migrants' Livelihood

Following the EPRP launched in 2005, the Ecological Migration Program in the THRHR, meaning local residents should move out from the reserve to restore the ecosystem and protect the environment, is deemed the country's largest scale ecological migration for eco-compensation (eco-compensation means a type of institutional arrangement to protect and sustainably use ecosystem services, and to adjust the distribution of costs and benefits between different actors and stakeholders, mainly through economic measures) (Wang et al. 2010). Although the achievements of ecological migration in the THRHR have been remarkable, there are also many unexpected outcomes such as unemployment and income shrinking of households (Wang et al. 2010). One may assume that the dramatically varying indicators of employment, unemployment, and the economically active population are linked to the types of economy existing in the THRHR. Despite resettled pastoralists having received subsidies from central and local governments, the migrant households cannot afford the necessities of life. Regarding replacement industries, due to commercial backwardness, migrants are lacking of alternative incomes in resettlement communities besides traditional animal husbandry. First, a big gap was estimated to exist between the demands for migrants' livelihood (for instance, estimated living expenditures of 17 000 Yuan RMB per household per year; fuel expenditures of 2394 Yuan RMB per household per year; and vocational training costs of more than 2000 Yuan RMB per person, etc.) and the subsidies the ecological migration provided (mainly including subsistence allowance of 8000, 6000, or 3000 Yuan RMB per household per year; subsidy of 500 Yuan RMB for living fuel per household per year; and 800 Yuan RMB per person for the vocational training of the ecological migrants, etc.) (Qinghai Institute of Economic Research 2008). Second, the ecological migration changed the migrants' income structure by making them shift from grazing to other activities or unemployment (Wang et al. 2010). Due to the long-term heavy dependence on grazing, the stable income from grazing of numerous former herdsmen (e.g., ecological migrants) was drastically reduced. Third, ecological migrants, with high illiteracy rate, have a general lack of job skills, and low capacity of re-employment. With social concerns over ecological migration already raised, ecological migrations are threatening local pastoralists' livelihood (Foggin 2011). Addressing these linkages adequately is a major challenge for sustainable livelihood of resettled pastoralists and poverty reduction in this area. Therefore, in the new stage of development, more attention should be paid to training in job skills, development of replacement industries, and cultivating alternative livelihood strategies, so as to guarantee a sustainable future for the ecological migrants affected (Fang et al. 2011a; GaDanCaiRang and Li 2011; Guan 2011; Zhou et al. 2010).

For Further Conserving of Traditional Culture

Many scholars have used concepts like "socio-ecological systems" to emphasize the humans-in-nature perspective (Berkes et al. 2001). Traditional ecological knowledge rooted in indigenous cultures plays an essential role in

contributing to local biodiversity conservation (Berkes et al. 2000). Shen et al. (2012) also confirms that a positive relationship between traditional cultures and biodiversity exists worldwide. In addition to ecological functions, ecosystems of the THRHR have immense livelihood, cultural, and spiritual significance for local communities. In the meantime, the special natural and cultural ingredients in the THRHR have brought about significant opportunities and challenges in the conservation and construction of ecosystems. On the other hand, the THRHR is the major nomadic region of Tibet and has a rich nomadic culture. As pointed out by Foggin (2011), cultural continuity can affect health independently, yet synergistically it is even a more powerful predictor of health and well-being. However, the nomadic culture is threatened by the ecological migration and economic factors from outside in recent years. There is a long-term commitment to maintain traditional ethnic cultures in the THRHR (GaDanCaiRang and Li 2011).

For Further Innovation of Eco-management Mechanism

Considering the sustainability and security of ecosystems, China has made some progress in eco-compensation in the THRHR since 2005. The government of Qinghai Province has started offering subsidies for migrant households in hardship since 2009, and has approved a plan to invest an additional 1×10^9 Yuan RMB (about 159 million US$) in extending the cover range of eco-compensation. However, as already mentioned, the subsidy provided by the government is not sufficient for the migrants' living. Chinese scholars have stated that legalization of eco-compensation is a key to the success of the conservation practice, but it is still at a conceptual level, and in practice there are some problems at present. Furthermore, these mechanisms such as disaster prevention and relief, investment, market, education and training, development of replacement industry, etc., need to further identify the basic rules and the innovation approaches according to specific features of the THRHR (Fang et al. 2011a; GaDanCaiRang and Li 2011; Guan 2011; Zhou et al. 2010).

Indication of Strategic Transformation of THRHR Management

For reasons mentioned above, it is desirable to have a comprehensive approach that recognizes the importance of the design and implementation of synergistic conservation and development strategies underlying sustainability in the 21st century for managing the THRHR nature reserve. The SITDR articulates a scientific and practical vision to solve these complex contradictions and balance all interests of stakeholders. Obviously, it is an important mark of strategic transfer from ecological engineering to social engineering, as well as a significant symbol of the state of the art philosophy in managing the THRHR nature reserve. From Fig. 3, the distinguished characteristics and the philosophy of strategic shift are as follows:

First, the shift of strategic objectives from ecological sustainability to social sustainability is embraced and championed in the SITDR. The mission of managing the THRHR has developed into a more holistic understanding of human–environment relationships as mutually linked. The priority of the EPRP is ecological protection, though economic development is also covered. Therefore, the EPRP will help conserve ecosystems, protect natural resources that are needed for local economic development and livelihoods. However, increasing inequity in income, wealth and opportunity necessitates a greater need for a balanced social and ecological prioritization. The SITDR aims to address precisely the integration of sustainable natural resource management with enhanced livelihood and well-being for local residents. Especially, the SITDR seeks to bridge the ecological, economic (e.g., food, clothing, shelter, wealth, etc.), social (e.g., job, poverty alleviation, public service capacity, well-being society, etc.), and cultural (e.g., nomadic culture, indigenous knowledge, etc.) values.

Second, increasing recognition is placed on the shift of resident's role from an obstacle to a motive force. The article conducted by Fang et al. (2005) takes a closer look at the local resident's role in China that provides a favorable context for balancing conservation and development. Fang et al. (2005) argued that a prerequisite to win the support from local people and to exert their roles is to highlight their concerns, to raise their incomes, to improve their living standards, and to respect their customs, in other words, to follow the people-oriented concept, and then to shift the role of the local residents from a burden to an initiative force (see Fang et al. 2005). A parallel experience of re-thinking development and conservation practice has unfolded in The EPRP. However, the EPRP contributed little to poverty reduction and people's livelihood improvement because it left local people outside the process of defining development needs and agendas. On the contrary, the livelihood improvement and role shift of local residents has become a top priority of the SITDR; based on the starting point, the SITDR is to maximize the residents' social welfare. The strong emphasis on the program with regard to not just securing pastoralist's incomes, but also the pastoralist's social functions, social status, and social cohesion, namely, the people's livelihood and well-being depends not only on income but also on access to social services. As a component of the biosphere, humans should be taken as an essential part of the reserve. It is the only way to achieve a sustainable future for the reserve (see Fang et al. 2005).

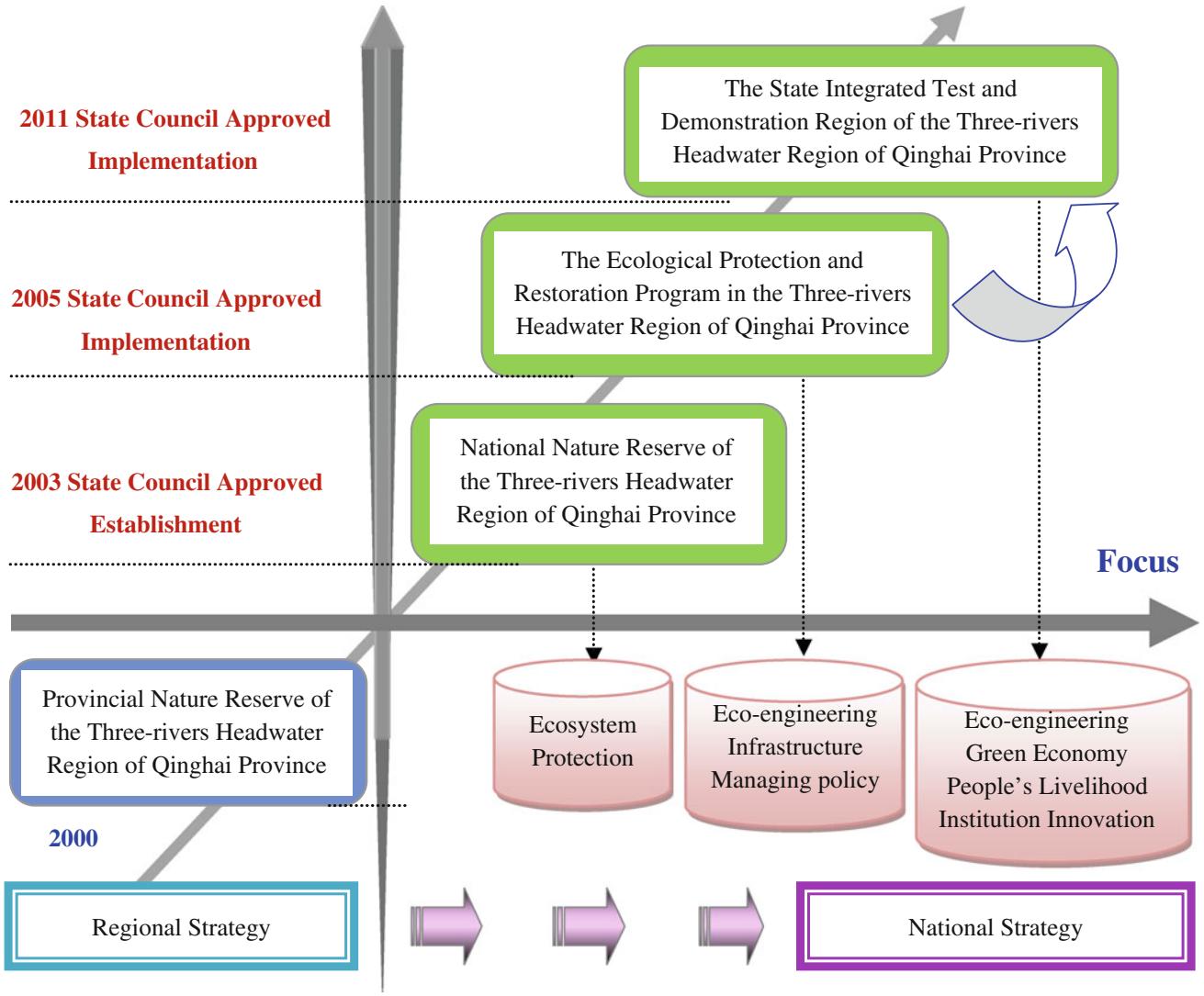

Fig. 3 The national strategic transformation diagram of managing the three-rivers headwater region of Qinghai Province

Third, the relationship shift between protection and development can be seen in the SITDR. In the developing world, poverty reduction and environmental protection should be tackled in an integrated manner (Adams 1990). The conservation of nature cannot ignore development concerns. Instead, they need to use development means to achieve their desired conservation ends. In this context, the SITDR recognized the importance to recast the relationship between conservation and development. The SITDR is designed to facilitate the coexistence of ecological, economic, and social dimensions, despite the increasing linkages between development and conservation that were presented in the EPRP. The proposed equal treatment of the three pillars in the SITDR is based on the evidence that pastoralist' s needs cannot be sufficiently met only through an ecologically stable and healthy environment, that equally economic and social needs ought to be taken care of as well. From this it should benefit not only the maintaining of ecological security for the Qinghai-Tibetan Plateau, but also developing innovative ways and patterns of multiple-pillar coordination.

Fourth, institutional innovation is a novel strategic transformation in the SITDR. The SITDR is devoted to a new institutional mechanism that is related to ecological conservation, livelihood improvement, economic development, cultural protection, and social harmony. Development of THRHR for a pioneer and demonstration region of ecological civilization is an important task of the SITDR. In the long term, ecological civilization will be an important part of human civilization. Coexistence between man and nature, and harmonization between economic development and the environment shape the core philosophy of

ecological civilization. Based on this connotation, ecological civilization includes the ecological awareness civilization, ecological legislation civilization, and ecological behavior civilization (Zhang and Zhang 2011; Zhang et al. 2011). In spite of this, the EPRP involves some form of practices such as eco-compensation, development of replacement industries, skills training and grassland management. A limitation to promoting respect of traditional cultures to improve livelihood strategies does not make much holistic sense of mechanism innovation in the THRHR. It is worthwhile to note that the governing of the THRHR nature reserve is not only a purely ecological engineering, but also a complicated social engineering. Ecological conservation often tends to be more convincing, and smooth successful experiences of integrated trade-offs of ecological protection, traditional culture conservation, economic exploration, and social development are a scarcity in the world at present. Therefore, the SITDR will serve as an example of ecological civilization and nature conservation, a demonstration that gains experience for the whole country in managing nature reserves.

Strategic Transformation Approaches of THRHR Management

In order to achieve this goal of the SITDR, major initiatives are as follows:

Ecological conservation should be incorporated into the policy making of climate change mitigation and sustainable development at local, national and international levels. Therefore, the main functional regions (e.g., key protected, protected and the general development areas) should be divided based on environmental carrying capacities. Studies on interactions between climate change and high cold ecologic processes, on climate change and maintaining high cold ecosystem functions, and on climate change and feedback of high and cold ecosystem should be encouraged. The objectives are to maintain a balance of livestock numbers and grassland carrying capacity, to establish monitoring and early warning systems of grassland degradation, to incorporate ecosystem risk management in national or regional development planning programs, and to develop natural disaster (in particular meteorological disasters and rodent' damage) risk mitigation guidelines. An effective management framework is to be formed based on adaptations to both the high cold ecosystem and livelihood improvement in the context of climate change.

In economic development, the central and local governments should pay attention to changing the exploration patterns of agriculture and animal husbandry, to improving the level of intensification in the farming, and to developing ecological animal husbandry, green agricultures and non-agricultural industries in this area. Indeed, in 2009, the Hainan Tibetan Autonomous Prefecture (part of the SITDR) has been approved as the only sustainable development experimental zone of ecological animal husbandry in China. This project will play an exemplary role in the transition from traditional to modern forms of animal husbandry.

In people's livelihood improvement, it can be argued that the most important task is to increase the income of pastoralists. Meanwhile, the central government and Qinghai province should increase public investment funds for further expansion of migrant's non-farm employment, establishment of a regular income growth source for local pastoralists through accepting free vocational training, and the establishment of venture capital funds. In addition, improving the social security system and the capacity of social services is another important aspect of improving people's livelihood, including establishing and improving the rural public service system (e.g., education, medical, health and community capabilities, etc.), strengthening the construction of infrastructure at the community level (e.g., transportation, communication, water conservancy, etc.), solving the housing and heating problem for disadvantaged groups, and accelerating the pace of poverty alleviation, etc.

In mechanisms innovation, special emphasis is put on the eco-compensation, livelihood improvement, professional organization, prevention of natural disasters, evaluation systems for environment-friendly performance, and confirming the indigenous cultures in conservation, etc. Especially the grassland ecosystem subsidies and award policies (mainly including subsidies for the banning of grazing, awards for the balance of grass and livestock, and subsidies for pastoralist's production materials, rural fuel consumption, etc.), the building up of a long-term effective ecological compensation mechanism, the development of mechanisms and policies for fiscal poverty alleviation, and the promotion of ecological pastoral cooperation organizations are the major pillars to promote the innovation of mechanisms.

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