10. Development scenarios on the Hetao Irrigation District and Wuliangsuhai Lake

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10.1 Introduction

The ecological changes occurring within the area of Wuliangsuhai Lake is closely linked with the agricultural development in the Hetao Irrigation District (HID). From our research, we argue that it is highly unlikely to preserve the Wuliangsuhai area as a lake without realising substantial change in the HID (see Chapter 2 for background information of this site). The shortcomings of previous work within Wuliangsuhai Lake and its surrounding area is a result from an isolation of the lake area, in which it does not take into account the causal nexus between the HID and the critical state of the lake itself. To clarify those causal linkages and to envision the prospects of Wuliangsuhai Lake in the future, qualitative scenarios (i.e. narratives or story lines) have been developed by the authors of this chapter, which have based different sustainability paradigms, proposed over a time span of 30 years. The general intention of our scenario writing was to sharpen awareness of local stakeholders regarding different possible routes of development and their probable outcomes. Scenarios generally postulate that the future is open to some degree and that present decisions and actions have impacts for better or worse. The different sustainability paradigms that underlie the scenarios include:

Part of
Cirella, G. T. & Zerbe, S. (Eds.). (2014). *Sustainable water management and wetland restoration strategies in Northern China*. bu,press. https://doi.org/10.13124/9788860461094

- intermediate sustainability (*scenario A*): conservation of "critical natural capital";
- strong sustainability (*scenario B*): maintenance and gradual increase of each kind of natural capital based on the Constant Natural Capital Rule (CNCR);
- weak sustainability (*scenario C*): maintenance of total capital (i.e. sum of natural capital and human-made capital); and
- non-sustainability (*scenario D*): worst case where a wasteland appears.

Figure 1 refers to the notion of natural capital which is presupposed in all of the four scenarios. The general notion is arranged as a scheme which comprehends different types of natural capital.

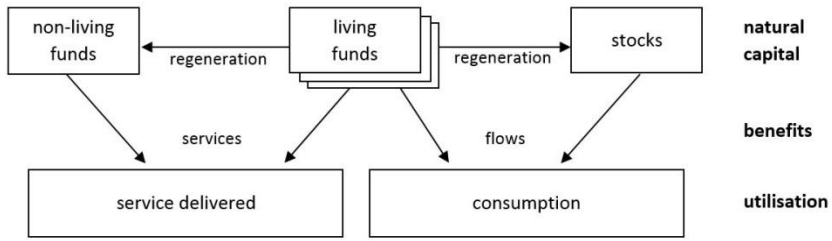

Figure 1 – Scheme of natural capital, based on Ott and Döring (2008).

"Natural capital" comprises of all those components of nature that bring some benefit or enrich the many capabilities of human beings and higher developed animals or serve as preconditions for utilisation (Ott & Döring 2008). The concept of natural capital refers to the many ways and modes on which nature has beneficial impacts on human (or animal) life. "Natural" does not mean that nature is free from any human interference (e.g. "wilderness"). It includes stocks and funds which have been modified by human action, but remain natural to some degree. Thus, we mostly face "cultivated natural capital" in Europe and China, for example.

The notion of benefit is not restricted to economic welfare but encompasses non-material benefits as well (e.g. recreation, aesthetics and the like).

"Critical natural capital" enables the provision of essential ecological functions and ecosystem services. Natural capital can be divided into stocks and funds (as described in Figure 1). Stocks yield benefit streams, while funds deliver services. Unlike stocks, funds regenerate or reproduce themselves; therefore, fund services continue over time if the respective fund is not depleted. Hence, the utilisation rate of such funds should not exceed their regeneration rate, if those service flows are to be maintained. One main cause of over-exploitation and depletion of natural capital is to perceive funds as if they were stocks. Different from natural capital, "human-made" capital cannot be found in the nature but must be produced. It includes production factors (e.g. equipment, input materials and so on), human capital, intellectual capital and social capital, etc. The sum of natural capital, human capital and human-made capital compose the total capital a given society holds at a given time or a given period of time. The different paradigms, therefore, propose different utilisation schemes on capital. In a nutshell, weak and intermediate concepts of sustainability allow for more substitution between different kinds of capital while strong sustainability is more demanding with respect to conservation and restoration of natural capitals, especially funds. A shift from the mere depletion of stocks to the restoration of funds is strongly required by strong sustainability (*scenario B*). Strong sustainability takes into account funds of cultivated natural capital. By doing so, the problem of substitutability eventually returns within this concept. Our scenarios address this problem.

Freshwater is a non-living fund under the above outlined scheme. In the HID and Wuliangsuhai Lake area, freshwater resources includes those from the Yellow River (diverted from the Sanshenggong Water Station) and those in Wuliangsuhai Lake. Figure 2 shows the consumption level of such natural capital. After the peak in the 1990s, water consumption in the HID and Wuliangsuhai area dropped below 5 billion m^3/yr (Bm^3/yr), which is similar to the level before the 1980s. The recent drop in water consumption reflects a stricter implementation of the water use quota regulation noted in the "Yellow River Water Resource Allocation Plan" (NDRC & MoWR 1998), however water consumption level still exceeds its assigned quota of 4

Bm³/yr. Freshwater is a highly critical natural capital in the region. Other types of natural capital include air, soil, forests, grasslands, coal and minerals. It is worth noting that natural capital like coal and minerals are stocks, which mean they can only be depleted and do not regenerate themselves on a human timescale. Once used up, their benefit streams stop and only their external effects remain (i.e. debris, waste and greenhouse gas emissions). At present, the HID and Wuliangsuhai Lake area depends heavily on such stocks of natural capital for energy generation and gross domestic product growth.

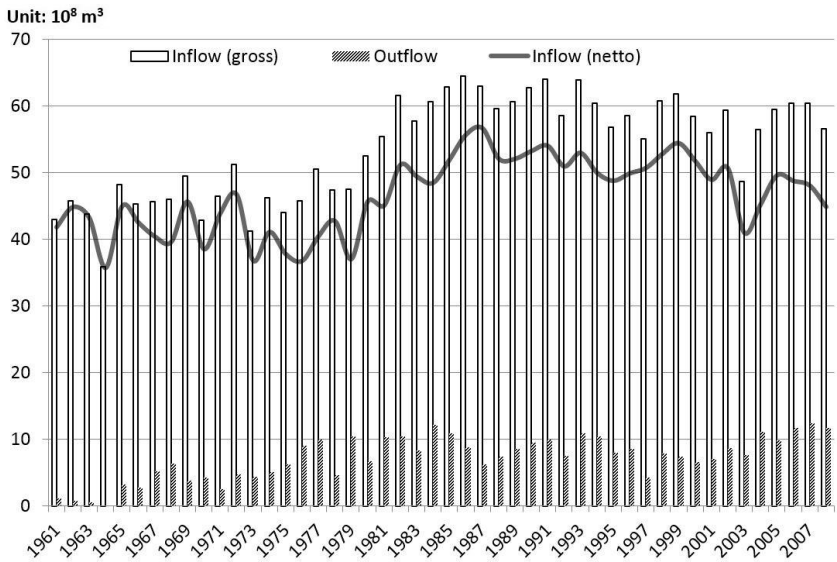

Figure 2 – Water resources in the HID and Wuliangsuhai Lake area. "Inflow (gross)" is the water amount diverted at the Sanshenggong Water Station, "Outflow" is the water amount returning to the Yellow River and "Inflow (netto)" is the linear overhead of the "Inflow (gross)" subtract the "Outflow" (BCPG 2010).

The details of the four scenarios are outlined in Table 1. In the first three scenarios, the back-casting technique has been applied. It asks in each scenario the question of "*What is to be done today to reach a specific sustainability goal?*" The fourth scenario highlights the possible consequences of a non-sustainability, "worst case" situation. Since those consequences are

to be avoided, there exists no goal in this scenario and the narrative is based on forecasting instead of a back-casting technique.

Behind the interaction between agricultural development and ecological changes in the HID and Wuliangsuhai Lake area, there are crucial drivers of changes (e.g. institutional re-arrangement, agro-technological advancement and environmental transformation). Initiating those changes are governmental authorities, actors in the private sector (e.g. industry) and in the agricultural sector (e.g. farmers and fishers) and non-governmental organisations (NGOs). Their action orientations differ greatly. Governmental authorities focus on securing food output that not only meets regional basic needs but also brings stable economic income through export to other regions throughout China. This could further contribute to social cohesion in the HID and Wuliangsuhai Lake area. Private sector actors include production agents outside the primary sector, comprising of agro-product processing enterprises. Their major concern is the return of investment. The locals (i.e. actors in the agricultural sector) include mainly farmers and fishers. They aim, as we shall assume, to maximise their incomes within a given institutional and technological framework. Lastly, local NGOs (i.e. Water User Association (WUA) and the Boya Cultural Association (BCA)) act on behalf of disadvantaged and under-represented groups (e.g. human beings of current and future generations, animals, landscapes, etc.). They are in close cooperation with other stakeholders. The stakeholder situation being given at HID and Wuliangsuhai Lake make it likely that short-term interest may, as often, dominate policy-making. On the other hand, however, stakeholders are searching for viable pathways out of a critical and inconvenient situation and actually hope to avoid the loss of Wuliangsuhai ceasing being a lake.

It is worth noting that *scenario A* can transit to either *scenario B* or *scenario C* with additional measures. Of course, *scenario B* and *scenario C* can also be developed from the baseline situation (see Chapter 5). During a project meeting in Linhe, Bayannur in 2011 local authorities and experts identified the region to be in the transition from *scenario A* to *scenario B*. However, the reality shows otherwise. With expanding areas of submerged vegetation and

increasing frequency of algae boom, the lake is on the verge between a grass type and an algal type ecosystem. Its fishery and tourist activities have basically come to a halt.

Table 1 – Scenarios for the HID and Wuliangsuhai Lake area, adopted from Kerschbaumer et al. (2014).

scenario A intermediate sustainability	*scenario B* strong sustainability	*scenario C* weak sustainability	*scenario D* non-sustainability
goal			
- conserving Wuliangsuhai Lake as a lacustrine ecosystem with an open water area remaining at ca. 293 km²	- developing Wuliangsuhai Lake into a Ramsar wetland of international importance under CNCR in the HID and Wuliangsuhai Lake area	- developing Wuliangsuhai into a palustrine ecosystem; expansion of a reed economy and establishment of sustainable tourism	- no goal, Wuliangsuhai Lake turning into a wasteland
measures (based on individual initiators)			
governmental authorities (focus: food security, economic prosperity and social stability)			- higher possibility of extreme events impacting area, especially the agricultural sector - high costs to construct more wastewater treatment plants - health threat to people in the region - threat of drinking water safety, especially to downstream regions - loss of income source due to disappearance of the fishery, reed or tourist industry - loss of cultural significance of the HID and Wuliangsuhai Lake area
- diversion of extra water (0.56 Bm³) from the Yellow River - water quota at 4 Bm³/yr; cultivation area at 5740 km² - promotion of innovative technologies like non-irrigation afforestation technology and water harvesting afforestation technology - promotion of organic fertilisers and enforcement of phasing-out old fertilisers - subsidisation of organic farming to farmers - establishment of a local fund for restoring Wuliangsuhai Lake - restoration projects in Wuliangsuhai Lake	- decrease of cultivation area to less than 5740 km²; regional land use based on Man and Biosphere - enforcement of organic farming during the take-off period (5–10 years) - setting incentives for agro-product companies to purchase organic crops from farmers at a fixed price - assistance programs to teach farmers required techniques (in cooperation with NGOs) - assistance programs to market organic agro-products from the HID (in cooperation with NGOs) - restoration projects in Wuliangsuhai Lake, including water diversion from the Yellow River	- incentive programs and policies to expand a reed economy - assistance programs to market reed products from the HID (in cooperation with NGOs) - construction of wastewater treatment plants in case of excessive nutrient discharge from the HID - establishment of a tourist industry in Wuliangsuhai Lake	

private sector actors (focus: return of investment)		
- business as usual - participation in the local fund to restore Wuliangsuhai Lake and in Water Rights Transfer projects	- participation in the local fund and Water Rights Transfer projects -investment in natural capital	- production of diversified reed products (see Chapter 8)
agricultural sector actors (focus: income maximisation without welfare jeopardisation)		
- new plantation scheme consisting of wheat, proso millet, sorghum, grain legumes and maize - return of suitable stalks of grain to the fields as fertiliser	- new plantation scheme consisting of wheat, proso millet, sorghum, grain legumes and maize - return of suitable stalks of grain to the fields as fertiliser -active participation in WUA -sustainable fish yield	- HID: business as usual - Wuliangsuhai Lake: fishers shifting to reed harvesting (in winter) and tourist industry (in summer)
NGOs (focus: protection of disadvantaged groups)		
- assistance in establishing a semi-water market - assistance to farmers in their transition to organic farming	- assistance programs to teach farmers required techniques (in cooperation with governmental authorities) - assistance programs to market organic agro-products from the HID (in cooperation with governmental authorities)	- assistance programs to market reed products from the HID (in cooperation with governmental authorities)

The severe environmental degradation in Wuliangsuhai Lake prompted reports and commentaries from major Chinese news agencies in 2012 on possible disappearance of the "Pearl of the Northern Frontier" in 20 years (Wu 2012; Li & Zhang 2012). The HID and Wuliangsuhai area is more likely to be on a path towards scenario C and, perhaps, scenario D. Scenario B, however, places strict requirements on the region to change their business-as-usual practices. Without sufficient political will, its realisation would be impossible. The next section argues that *scenario B* is most desirable and still feasible but implies short-term opportunity costs.

10.2 The case for *scenario B*

Scenario B adopts a holistic view, asking for the maintenance and gradual increase of natural capital in the whole region (i.e. CNCR), and not just a particular kind of natural capital in a specific location. Freshwater in Wuliangsuhai Lake is no doubt a critical natural capital in the region. However, other kinds of natural capital should not be left aside or sacrificed, like forests and grasslands. Just as in the fishery sector in Wuliangsuhai Lake, the utilisation of forests for commercial wood and grasslands for husbandry is to follow the concept of principle of sustainable yield (i.e. the harvesting rate not exceeding its reproduction rate). Responsible governmental authorities should cooperate closely with each other for sustainable use of respective natural capital, instead of chasing individual GDP performance. This means for some or all governmental officials a departure from their respective "comfort zones", and a relatively radical shift in the routine and logic of interactions with each other on the individual, as well as, departmental level.

Secondly, expanding organic farming poses great challenges to all stakeholders. Despite governmental policies promoting organic farming, organic agriculture does not yet have sufficient competitive advantages in China, as a whole, compared with traditional agriculture. This lies in, above all, the underdeveloped system of the organic agro-industry in all operation stages, including production (especially the educational level of farmers) and sales and certification versus insufficient informational transparency in the whole of the industry (Chang-wei et al. 2010). The development of organic farming in Dengkou County, Bayannur illustrates exactly this issue in which the project faced a dilemma after financial support from its cooperation partner ceased. The taking-off of organic farming (i.e. in the first 5–10 years), as *scenario B* requires, is to be enforced by governmental authorities. The enforcement should not lower the welfare level of farmers or related parties in the agro-production chain. Without *scenario A* as transition in which organic farming is promoted, the pressure on governmental authorities becomes even higher in terms of investment in infrastructure and financial assistance to farmers and agro-product enterprises during the taking-off

period. Governmental assistance for capacity building should continue even beyond the take-off period, say, for at least 30 years (i.e. the proposed time span of the scenario study).

Furthermore, the constraint on the farming area, which totals 5,740 km² within the HID and Wuliangsuhai Lake, at the same time puts a limitation on agricultural output. Even if organic farming might be as productive as traditional farming, a decrease in total output might be highly possible due to farmers being unfamiliar with the new praxis. Sustaining the welfare level of related parties in the agro-industry appears to an extreme challenging task for the government. For farmers, the new praxis plus new plantation schemes bring uncertainty in terms of their income. This could be one of the major obstacles to enforce organic farming if farmers insist on their routine praxis and are unwilling to shift to the alternative path. Figure 3 shows the dominating cultivation of melons and tomatoes since about the early 1990s, followed by sugar and oil plants. It takes, therefore, time to shift this routine cultivation praxis to a new one. Stable policy, informational transparency and successful examples could release such concerns. It is essential for farmers to take active part in the decision-making process, for example through respective WUAs. This requires a corresponding educational level as well as a local culture to promote democratic management. At the moment, the above mentioned seems still to be lacking far behind.

Thirdly, commitment of industry to invest in natural capital is difficult to establish. Industrial participation in Water Rights Transfer projects is in most cases determined by related policies, and is not an option if new industrial projects require extra water. Similarly, it is possible to implement the local fund through governmental regulations. Also, there could be regulations to restrict the establishment of industries with high water demands or with high potential of water pollution.

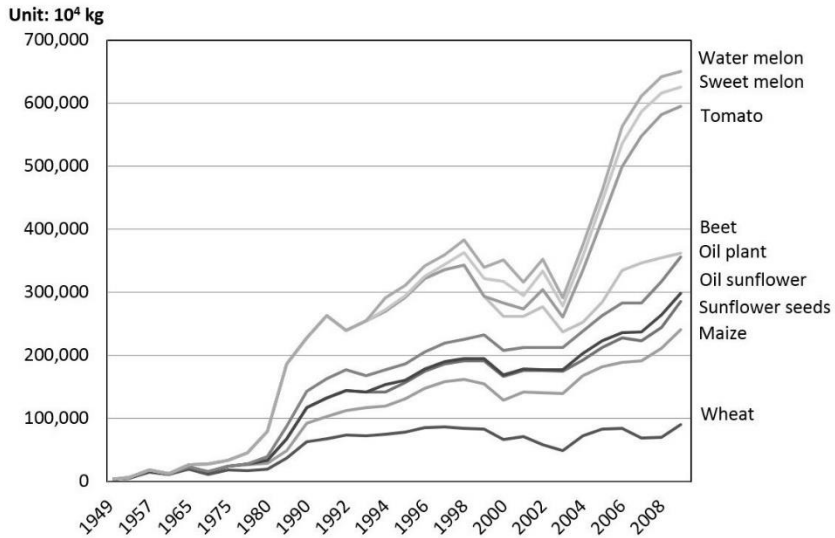

Figure 3 – Agricultural output of major crops in the HID between 1949 and 2009 (BCAH 2013).

Difficult to reach are binding commitments for the investment in natural capital from the industrial sector; that the industrial sector is a major contributor to regional GDP growth endows them with certain power on the negotiation table, which quite often rends environmental protection regulations void. If CNCR is to be held, the widespread guideline of "polluting first, cleaning follows" in existing policies and regulations needs to be discarded. However, since pollution discharge fees are a major income source for environmental protection authorities, there lacks incentives for a change. Shifting the function of environmental protection authorities is a long-term task that requires bold political reforms. Furthermore, even though activities to protect the environment might improve corporate image, enterprises in the market economy, especially small and medium sized ones, have the foremost goal of winning profit. Profit maximisation is frequently prioritised over environment and social responsibilities. In a situation where a solid corporate social responsibility (CSR) system is missing, as it is at present, achieving strong sustainability looks highly unrealistic.

Fourthly, influential NGOs are missing. In the HID and Wuliangsuhai Lake area, existing NGOs include various WUAs and the BCA. The former focuses on water issues, while the BCA focuses on the protection of Wuliangsuhai Lake mainly through training programs. As such, the limited focuses within a constrained political framework make it difficult for NGOs in China as whole to fully function. In their cooperation with governmental authorities or with industry, they quite often find themselves being directed rather than initiating direction. Nonetheless, strong sustainability asks for active roles from stakeholders in an equal manner. NGOs represent, above all, disadvantaged groups. Therefore, their constrained influence means limiting voices of those groups. However, if strong sustainability is to be achieved, the voices of NGOs should be taken seriously. It requires the independence of NGOs, and hence changes in the political culture in China. It is, of course, possible to start those changes bottom up, that is, on the local level. However, there still lacks political will in the Bayannur local government in this regard, or better said, the issue is not even on the agenda.

In conclusion, the management guideline of "polluting first, cleaning follows" runs exactly in the opposite direction of strong sustainability. It allows depletion of natural capital for the purpose of achieving growth in human-made capital. Restoring after polluting is very difficult in such a semi-arid region like the HID and Wuliangsuhai Lake area. End-of-the-pipe solutions will only help in the short-term. They cannot halt environmental degradation in the whole of the ecosystem. On a larger framework, such management guideline violate the principle of "Maintaining the Healthy Life of the Yellow River" (HLR) put forward by the Yellow River Conservancy Commission (see Kerschbaumer and Ott (2013) for a detailed discussion on the HLR approach).

Wuliangsuhai Lake is an integral part of the Yellow River. HLR, hence, applies on a regional scale. The "health" of the Yellow River requires a healthy Wuliangsuhai Lake. What, then, does "healthy" mean? The Wuliangsuhai Comprehensive Treatment Plan ("the Plan") by BCPG (2010) sets out the following two goals:

1. On the short-term, i.e. 2008–2015: to maintain water level, ensure ecological water demand, reduce inflow pollutants by 50 %, maintain water quality at Level V according to the national "Environmental Quality Standards for Surface Water (GB3838-2002)" (MoEP & QSIQ 2002), bring down the extent of eutrophication and paludification, increase biodiversity level, and reduce soil erosion;

2. On the long-term, i.e. until 2020: to bring pollutant sources and soil erosion under control, further reduce the amount of inflow pollutants by 20 %, enhance water quality to Level IV, and complete improvement of the aquatic ecosystem.

Just as proponents of the HLR approach, the initiators of the plan adopt a functionalist understanding on "(ecosystem) health". However, it should be noted that the notion itself entails requirements on both the natural properties as well as social properties of concerned ecosystems – "a dialectical unity" as HLR proponents argue. The plan, therefore, inherits partiality in its goals. It needs to take social properties, particularly cultural and spiritual values, into consideration as well. The HID and Wuliangsuhai Lake area is a highly diversified society in terms of ethnic cultures. The ethnic groups of Han (i.e. Daoist and Confucianist traditions), Mongols and Tibetans (i.e. Buddhist traditions) have their own cultural perception on water and on what should be considered ethical in utilising it. These social aspects are important if strong sustainability is to be placed. After all, hydrological problems are "wicked", where "true-false" solutions are not possible but "better-than" ones (Norton 2005). Cultural values play an important role in searching for "better-than" solutions.

From an institutional perspective, *scenario B* follows the CNCR rule, that is, combined with other widely recognised and applied principles, like those from the Convention on Biological Diversity (CBD) and the Ramsar Convention on Wetlands (Hu & Ge 2004; RCW 2005). CBD's central guiding principles are "the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources" (UN 1992). Ramsar promotes the wise

use of wetlands, defined as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development" (RCW 2005). The above principles need to be made operational on the local level in the HID and Wuliangsuhai Lake area. This is only possible with a strong political will to reform the current institutional structure and sufficient capacity of all parties involved to participate in practical discourses. All in all, contrary to what local authorities and experts expect, the HID and Wuliangsuhai Lake area is still far away from achieving strong sustainability, but appears rather to be nearing *scenario D* where Wuliangsuhai Lake turns into a wasteland. Besides the possible consequences outlined in Table 1, Wuliangsuhai Lake is likely then to undergo a process of salinisation, becoming potentially a source of sandstorms. *Is there a way out?*

The answer can be "yes". The proposed set of four scenarios should not be considered as a "finished" set. Scenario analysis as a technique in future studies aimed at expanding the visions on a given issue and supporting decision-making. In the case of the HID and Wuliangsuhai Lake area, the basic scenarios are developed in order to set off discussions among stakeholders. Measures proposed in each scenario are subject to negotiation and argumentation. During the dynamic decision-making process, stakeholders can combine various elements in the basic scenarios to form a new set of scenarios. For stakeholders in the HID and Wuliangsuhai Lake area, the above discussed challenges come with different degrees of difficulty with varying time-span requirements. For instance, the taking-off of organic farming practices might borrow experiences from successful cases (e.g. like in Dengkou County), and therefore would be relatively easier than institutional reforms to establish a democratic decision-making system in the region.

As said above, stakeholders are free to establish new scenarios after thorough considerations of various components in the basic scenarios. It is essential that all stakeholders participate with equity in this process, and not just the experts and authorities. The way out from a wasteland scenario

towards a way in to a sustainability scenario is still possible if all those involved work together towards meeting the challenges outlined above. Institutional re-arrangement, corporate social responsibility and capacity building play critical roles in achieving this goal. The following are some concrete suggestions:

Institutional re-arrangement

- setting clear regional development goals under the strategy to "establish a harmonious society" and to "construct ecological civilisation" put forward by the central government;
- establishing a fair benefit-sharing system through legislations;
- improving policy implementation especially regarding environmental assessment and payment for ecosystem services;
- replacing GDP growth as standard to evaluate governmental performance with sustainability indicators;
- improving inter-departmental cooperation among governmental units;
- strengthening the role of NGOs in the regional decision-making process;
- increasing financial support (both from public expenditure and private investment) to capacity-building for locals, especially the disadvantage groups;
- raising awareness in all walks of life and society for environmental values; and
- establishing a culture of open dialogue.

Corporate social responsibility (CSR)

- establishing CSR in agro-product enterprises to promote responsible water use and "*wu gong hai nong chan pin*" (agro-products without public hazards); and
- establishing CSR in the industrial sector for responsible water use in terms of their impacts on regional water quantity and water quality and in terms of commitment to invest in regional natural capital.

Capacity building

- skills and techniques for organic farming praxis in HID (farmers);

- capacity for sustainable fishery and tourism within Wuliangsuhai Lake (fishers and agents in the tourist sector);
- awareness for environmental impacts; and
- capacity to actively participate in practical discourses.

10.3 Conclusion

In principle, people are free to choose any scenario. This freedom of choice, however, should not be confused with moral and political autonomy. While freedom of choice, as in consumerism, might rely merely on given interests and preferences, moral and political autonomy rely on reasons which presume to transcend narrow egotism with respect to the common good. As we have argued in the previous section, there are such reasons that clearly speak in favour of *scenario B*. The concept of ecological civilisation which has become prominent in contemporary China, is highly coherent with *scenario B*, while it is clearly incompatible with *scenario D*. As we have argued elsewhere (Kerschbaumer et al. 2014), *scenario C* implies large risks since it might be collapse into *scenario D* if boundary conditions, as climate, may change. As we have argued, *scenario B* is desirable, feasible, and viable.

Desirability can be substantiated in terms of sustainability but the term "Pearl of the Northern Frontier" implies that the loss of such "pearls" is undesirable.[1] The tragedy of contemporary China might be that it is losing its natural "pearls" and receives some commercial goods and infrastructures in return. This is "weak sustainability". Feasibility can be substantiated with respect to institutional change and new incentives in HID. Change does not come about by itself but it requires political action, prudent transition management and even leadership. In situations of crisis, persons matter. Viability can be predicted with some confidence. As we know from many cases in protected area management, initial resistance of local people often

1 This is a conceptual remark we hold to be true by conceptual implication. If a natural item is termed "pearl", then it is valued as being precious. It is obvious that it is undesirable to lose something that is precious. It is incoherent to argue, "X" is highly precious to me but I do not care at all if I lose "X". See Ott (1997, Ch. 2) where such implications are further elaborated upon.

changes into acceptance if the new regime has been established and can realise its benefits.

The still existing "window of opportunity" to reach *scenario B* is, however, gradually closing and it would be practically impossible to reach the targets of *scenario B* if *scenario C* or even *scenario D* have come into existence. Current decision-making has to face this kind of irreversibility. If so, all stakeholders and authorities cannot deny their moral and political responsibility since they are clearly facing disaster and evil.

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