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VIEWPOINT

Reconciling the regulations and conservation of the Lhasa River, Tibet

Hai-Jun Yang and Liang-Jun Hu

The Lhasa River of Tibet (figure 1), flowing through the Lhasa City with a main stream length of about 555 km (345 mi) and a mean gradient of 0.29%, is the largest tributary of the Brahmaputra River, which is traced back to the Pangtso Lake at the southern face of the Nyenchen Tanglha Mountain. Lhasa, the long-standing capital of Tibet, plays a particular role in the life of Tibetans with regard to history and customs. The Lhasa River critically supports agricultural irrigation, township water supply, and even the formation of certain traditions of local Tibetans. As a consequence, any regulation/conservation activities imposed on the river may also cause unexpected (or potential) threats to the fragile surrounding environments. Thus, conservation practices for the Lhasa River should incorporate and reconcile multiple objectives, such as concerns about flood prevention, safety, ecological health, aesthetics, and ethics.

Figure 1

The Lhasa River (off-town portion), Tibet.

Flood prevention has been a challenge for the Lhasa River for a long time (Wangdui 1988; Xu 2001). As early as 1562, heavy storms flooded Lhasa (Fang 1996), causing a long-standing fear of flooding threats. The new China has made flood preventions of the Lhasa River a priority. In the summer of 1962, several lasting storm events resulted in a sudden water level rise in the Lhasa River so that the city was completely under water (Xu 2001). In response, the state decided to initiate an integrated control over the Lhasa River in 1964. However, the poor fiscal condition of China at that time meant that investment could not be sufficiently high. People were organized to build river dikes using nearby rocks, soil, and collective labor, often without any financial support (Fang 1996), which usually generated limited flood combating effects. By contrast, more intensive regulations of the Lhasa River were triggered in recent decades. A two-step Lhasa River Dike Protection and Consolidation Project, entirely funded by the central government and with a budget of about US$70 million, was launched in 2002 and in 2009. The major goal was to build a 26 km (16.2 mi) high standard flood prevention dike system for the river.

Hai-Jun Yang is a professor and **Liang-Jun Hu** is an associate professor at the Key Lab for Vegetation Ecology Sciences, Ministry of Education, Northeast Normal University, Changchun, Jilin, China.

MAJOR CONDUCTED MEASURES, ACHIEVEMENTS, AND CHALLENGES

In the river-regulating activities for the Lhasa River, flood prevention is a major concern and thus a priority. In practice, river-dike building and consolidation and dam construction have been employed as primary regulation measures. Some turning fractions of the river were reshaped at will, which created straight-lined channels that could greatly ease pressure of threatening flows during flooding seasons. Concrete-stone engineering materials were widely used to consolidate the river banks. These bank slopes were often built with gradients ranging from 30° to 90°. In general, the engineering design criteria for flood prevention have been upgraded by about ten times, e.g., the warranty length is raised from 20 years to 200 years (Sun 1997).

These steps have much decreased the risks of Lhasa City flood damage. For example, in recent years, Lhasa has encountered several flooding events without suffering any loss, which has provided a good infrastructure to support the economy and sustain development of the area. In the meantime, many well-known historical landmarks, such as the Potala Palace and the Grand Dazhao Temple, have been well preserved from flood damage.

In addition, a new integrated water conservancy project—the Pangdo Hydropower Hub Engineering Project—is being carried out at the upper reaches of the Lhasa River (Hu and Wang 1999). This project was planned with the major goal of supporting local agricultural irrigation and electric supply, as well as with the goals of flood prevention and township water supply for the downstream reaches of the river. After completion, the dam-created reservoir will have a water-holding capacity of about 12.3×10^8 m^3 (3.235×10^{11} gal), with an electric plant loading capacity of 1.6×10^8 W, supporting irrigation of an area of 4.819×10^4 ha (1.191×10^8 ac). This project was started in July of 2009 and is scheduled to be completed in 2015, with a total investment budget of about US$0.725 billion (Mo 2008). The Pangdo Hub Engineering Project is expected to significantly boost the flood prevention ability of the Lhasa River watershed and also could improve the infrastructures for local agricultural activities.

Apart from the concerns described above, the construction of integrated riparian vegetated buffers and riverside leisure landscapes and facilities has been also included in the projects for the sake of soil and water conservation, aesthetic needs, and convenience of the local residents. Albeit these measures have taken effect to some degree, many engineering details still need improvements before we are able to properly assess the impacts of the engineering activities and vast investments behind them.

Particular challenges that resulted from the regulating activities and that may threaten conservation of the river are as follows:

1. Engineering activities (e.g., dam constructions) may cause severe soil and water loss due to the vulnerable environments of the Tibetan Plateau (see figure 2). The Lhasa River Watershed belongs to a highly fragile and susceptible area prone to hybrid soil erosion danger caused by wind, water, and freeze-thaw actions (Zhong et al. 2008; Hu et al. 2009; Hu 2012). Improper anthropogenic activities, such as overgrazing, overfarming, or engineering construction, would result in quick declines of the native, poor vegetation covers and thus losses of the soil and water. For example, the documented sediment loss transported through the Lhasa River during the 1970s was about 8.24×10^8 kg (8.24×10^5 tn); it increased to about 1.001×10^9 kg (1.001×10^6 tn) in the 1980s and then to about 1.80×10^9 kg (1.80×10^6 tn) in the 1990s (Cao et al. 2006), implying an increasing intensification in human perturbations over the area. These sediments often jammed the river channels, dampening an efficient retreat of floods. The sediment-entrained nonpoint source pollutants and the unprotected discharge of construction-generated waste oil would worsen the water quality of the river as well.

Figure 2

Near-river section degraded by engineering activities.

2. Dams and widely-used stifling mulched or hardened riversides greatly change and preclude the local water cycles in rivers. Although dam engineering plays critical roles in manipulating irrigation, generating electricity, and preventing floods, it also thwarts the natural river flow, often causing conflicts in water resource management between up- and down-stream reaches, change in water cycles, and biodiversity loss in the watershed. Similarly, stifling mulched riversides, by segregating the linkages amongst surface waters, groundwater, and river flows, may result in a changed refilling regime (usually inadequate) of soil water and groundwater, damage the eco-corridors between aquatic and terrestrial interfaces, and thus weaken the self-cleansing abilities of the rivers (Yang and Li 2005).
3. Although vegetation reconstruction and landscape creation elements have been considered in regulation activities, riverside vegetative buffering systems have not been well designed and built with regard to pollution prevention and water conservation. At present, there is no real integrated riparian forest and riverside vegetation buffer system along the Lhasa River (figure 3).
4. At present, there are still legal conflicts in implementing conservation measures and regulating activities about rivers in China. For instance, according to the Water Pollution Prevention Law (China Congress Law-Works Committee 2008), some controlling measures, such as the "T-shaped" dikes, drifting "vegetation-isles," and plant barriers/filters, could be placed in the threatened rivers while in need. However, these are definitely prohibited by the state's Water Law (Cao 2003) and Flooding Prevention Law (China Congress Law-Works Committee 1997).

SUGGESTED SOLUTIONS AND STRATEGIES

The Lhasa River not only plays a role in affecting the local water cycling patterns, but also in coping with soil and water losses in the watershed and other issues in ecology, disaster reduction, water resource management, landscape creation, and cultural protection. To achieve the multiple objectives of regulating the river, we raise suggestions that may help tackle the challenges through reconciling the major regulation measures and conservation issues, as discussed below.

Conducting Integrative Soil and Water Conservation Initiatives at the Watershed Scale over the Lhasa River Basin. It is proven that an integrated soil and water conservation scenario based on the watershed scale, instead of applying some single controlling measures, is effective in reducing soil and water loss (Zhang et al. 2005; Cao et al. 2006) and also provides a foundation for flood reduction and prevention. In particular, protective measures during dam constructions and other engineering activities must be carefully carried out under inspections. During the running of the Pangdo Hub works, a mechanism for effectively managing the water resources over the Lhasa River watershed needs to be built.

Using Eco-Friendly Surrogate Materials and Ecological Engineering Design Principles to Rehabilitate the Local Water Cycling Regimes. The use of concrete materials should be greatly reduced in building the riversides. Particularly, the stifling mulched riverside slopes should be completely avoided.

Building Integrated Riparian Vegetative Buffering Systems. Vegetated buffers can protect adjacent wildlife habitat, wetlands, and water bodies from harmful human activities (Liu et al. 2008). A riparian vegetated buffer with proper structures and placement can effectively intercept sediments and reduce nutrient loading and other nonpoint source pollutants from surface runoff, which thus can significantly improve the water quality of rivers (Lee et al. 2003; Verstraeten et al. 2006; Qiu et al. 2009; Yuan et al. 2009). In addition, it can help create a pleasing riparian forested landscape. In Tibet, grassy filter strips, bush belts, and riparian forests should be spatially integrated and placed properly along the river under the principles of landscape design and ecology.

Amending Related Legal Items. Laws provide a policy foundation for regulating actions. To guarantee fine regulation effects based on the reconciliations between regulation measures and conservation of the river, legal barriers must be eradicated. Therefore, the present Water Law and the Flooding Prevention Law of China should be amended to reconcile with the Water Pollution Prevention Law.

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Figure 3

There is no riverside vegetation buffer system along the Lhasa River.

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