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Large-scale Hydroelectric Projects and Mountain Development on the Upper Yangtze River

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The upper Yangtze River is extremely rich in hydropower, with 9 large-scale hydropower projects planned and 2 under construction. Current and projected large-scale hydropower projects pose difficult challenges as well as great hope for development of local impoverished areas. There are great difficulties in coordinating hydropower development and local regional development, owing to gaps in national policies, clear separation between enterprise and local communities, and problems with local management and

the local economy. The local government faces the dilemma of supporting national hydropower development on the one hand, and safeguarding the interests of local people on the other. Local regional development requires general planning and a proper national policy for resettling dam migrants. A special national eco-district is proposed to delimit reaches in the upper Yangtze River area that will provide ecological security for the developed reaches and the dams lower down on the Yangtze River.



The appeal of hydropower on the upper Yangtze River

China is expected to quadruple its gross domestic product (GDP) between 2001 and 2020, while doubling its use of energy during the same period. Owing to the rising price of oil in the world and the high risk associated with nuclear energy, hydropower development has become a major energy strategy worldwide, with a substantial increase in reliance on hydropower in China. The appeal of hydropower is clear: it is potentially an emissions-free way to meet China's expanding energy needs,

and many dam projects provide multiple benefits.

By 2020, China aims to produce 200–240 GW of hydroelectricity, which means adding 7–9 GW of new hydropower capacity per year. To meet this goal, China will need to build the equivalent of roughly 1 Three Gorges dam every 2 years. Fortunately, there is an enormous potential for hydroelectric power in the upper reaches of the Yangtze River, especially in the section of the mainstream above Yibin and below Yushu, namely the Jinsha River (Figure 1). Flowing for 2360 km from the eastern Tibetan Plateau to the low-lying Sichuan Basin, with a drop of 3280 m, the

FIGURE 1 The Yangtze and Three Gorges Reservoir region, with the location of the 4 planned dams upstream, in the lower Jinsha River. (Map by authors)

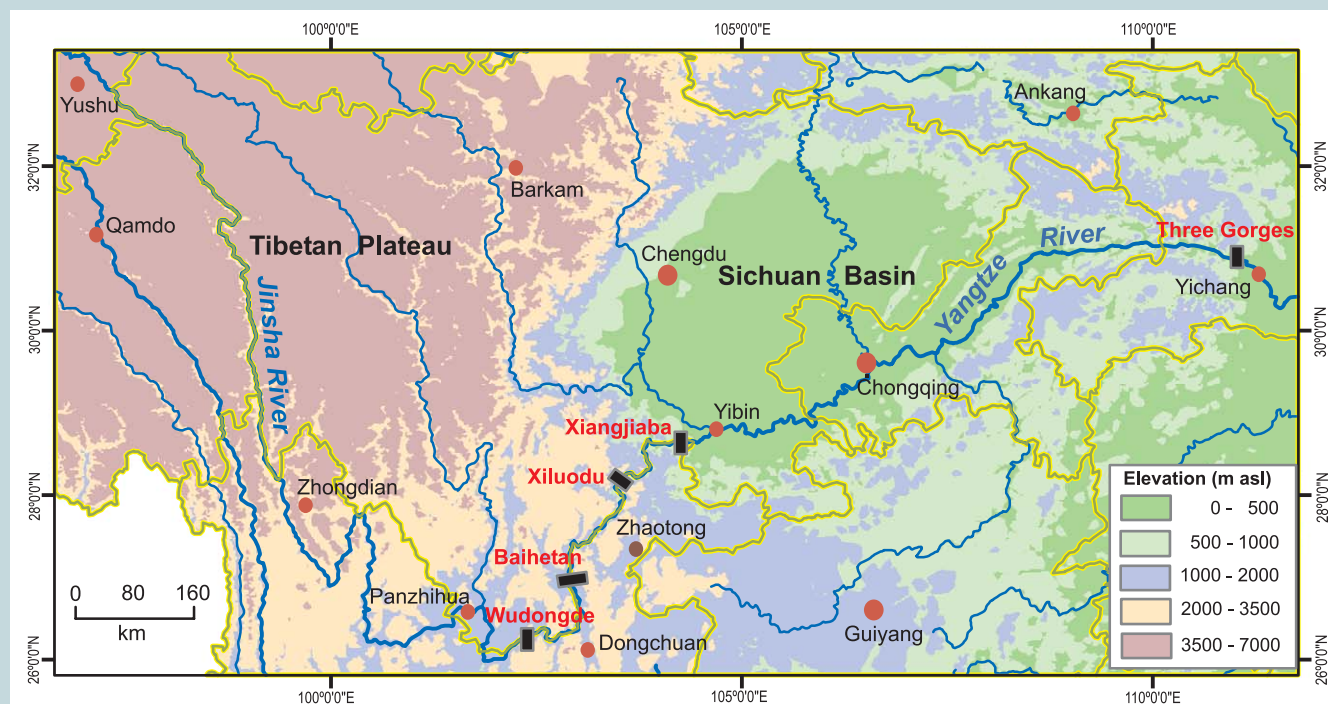


TABLE 1 Characteristics of the main hydropower projects in the lower Jinsha River compared with the Three Gorges dam. (Source: Wu 2004)

| Dam | Storage capacity (billion m ³) | Installed capacity (GW) | Migrants | Investment (yuan/kWh) ^{b)} |
|--------------------------|---|----------------------------|--------------------|--|
| Wudongde | 4.0 | 7.4 | 14,200 | |
| Baihetan | 19.2 | 12.0 | 80,500 | 0.797 |
| Xiluodu ^{a)} | 12.9 | 12.6 | 32,000 | 0.796 |
| Xiangjiaba ^{a)} | 5.2 | 6.0 | 79,000 (97,300) | 0.765 |
| Three Gorges | 39.3 | 18.2 | 1,200,000 | 1.07 |

^{a)} Under construction^{b)} 8 yuan = US\$ 1

Jinsha River has an enormous potential to supply hydropower—as high as 112.4 GW, of which about 75.120 GW is exploitable.

Currently, a total of 9 hydroelectric dams have been planned for the middle and lower Jinsha River reaches, 4 of which are in the lower Jinsha River (Figure 1). The 4 planned reservoirs have a total installed capacity of 38 GW, more than double that of the Three Gorges (18.2 GW). Hydropower development unfolded in 2003, with the start of the Xiluodu project, the second largest hydroelectric project in China, following upon water storage and power generation at the world-famous Three Gorges project located at the end of the middle Yangtze River. In this sense, construction of the Three Gorges dam was only the prelude to hydroelectric development in the Yangtze River.

Development of hydroelectric energy in the lower Jinsha River has proven to be very cost-effective (Table 1). The invest-

ment per unit of energy is generally less than 0.8 yuan/kWh (US\$ 0.1/kWh), obviously lower than the 1.07 yuan/kWh (US\$ 0.13/kWh) for the Three Gorges. In particular, there are far fewer people to be resettled compared with the enormous number (1.2 million) resettled as a result of the Three Gorges project. Therefore, hydropower development along the Jinsha River is believed to be quite feasible.

Positive and negative impacts of large-scale hydroelectric projects

Three of the 4 hydropower projects in the lower Jinsha River—Baihetan, Xiluodu, and Xiangjiaba—mainly affect Zhaotong City on the eastern bank of the lower Jinsha River (Figure 1), in the northeast of Yunnan Province. Typically densely populated (5.2 million inhabitants in 2004) with limited available land (23,020 km²), this area is characterized by poverty, mountainous terrain, and ecological fragility (Figure 2). The city itself is also characterized by poverty, with a very low annual per capita income of less than US\$ 800. The local government and residents have good reasons for and high expectations regarding hydropower projects to promote the regional economy.

Potential benefits

Theoretically, major investments due to hydropower projects should be a powerful driver in developing the local society and economy. Hydropower projects could provide local residents with clean energy, hopefully reducing forest logging, protecting the mountain ecosystem, and promoting the regional economy. Large water

FIGURE 2 Buildings on concrete stilts show the extreme scarcity of flat land suitable for construction in the densely populated Zhaotong City area. (Photo by Zhang Baiping)



surfaces could regulate the local climate. Waterways could be opened from Shuifu (very close to Xiangjiaba) to Xiluodu, greatly enhancing the accessibility of counties along the river. Water storage from these projects could enormously expand water bodies and improve production conditions for the aquatic industry.

Moreover, the projects could provide opportunities for employment, building materials, and agricultural and other by-products. There is also a potential to optimize industrial structures. With compensation for migrant resettlement and displacement, and reconstruction of cities and towns, enterprises, and infrastructure, it would be possible to upgrade low-yield farmland, rationally redistribute the population, greatly develop the secondary and tertiary sectors, and promote population flow from rural areas to cities and towns so as to reduce population pressure on agricultural land, especially sloping farmland.

But past experience has also taught that hydropower development will not necessarily improve local social and economic conditions. The negative social and environmental effects of hydropower projects appear now to be more obviously felt. Current and planned large-scale hydropower projects pose tough challenges as well as great hopes for future development.

Resettling migrants

The three hydropower projects in the lower Jinsha River will above all necessitate the resettlement of 180,000 residents (Table 2) and displacement of a whole county town and 9 townships in Zhaotong City. Although this figure—especially when examined for each project—is much lower than figures for the Three Gorges project, the difficulty of resettlement is far greater. The main reasons for this are the following:

- *Difficult conditions for resettlement.* External population displacement is almost impossible, as hardly any places are willing to accept people for resettlement. People in this case have to be relocated in northeastern Yunnan. As stated above, this region has few patches of flat land, hence people have to be

resettled in mountainous areas. “Up-slope displacement,” ie moving populations up the slopes, has been determined as the main model of resettlement. But moving to higher and steeper mountain slopes means worse conditions both for life, production, and the environment.

- *Low compensation for dam resettlement.* Compensation for dam resettlement is currently set at lower rates than resettlement for transportation projects or urban development. Money to increase compensation could come from a 0.0001 yuan (8 yuan \approx US\$ 1) tax on each kWh of electricity generated by a new dam. A 1981 circular from the Ministries of Water Resources and Power and the Ministry of Finance recommended precisely this tax, but it has never been implemented.
- *No proper mechanisms to guarantee the vital interests of local residents.* An administrative order from the government of Yunnan Province, in the name of supporting national hydroelectric construction, can expel residents from the town where they and their ancestors have lived for hundreds of years. The local government and residents seem to have no alternatives. They have no opportunity to participate in decision-making processes relating to their lives and to production. All relevant decisions have been made by the hydropower development enterprise and the provincial leaders.
- *Dilemma for local governments.* Local governments are in a very embarrassing position, neither ignoring the lack of benefits for local residents nor oppos-

TABLE 2 Projected reduction of farmland area and projected displacement of population in Zhaotong City. (Sources: Wu 2004; Wu 2005)

| Hydropower project | Inundated farmland (ha) | | Residents to be displaced | |
|--------------------|-------------------------|------------------|---------------------------|-------------------|
| | Total | Irrigated fields | Total... | ...of which rural |
| Baihetan | 4000 | 800 | 67,000 | 64,000 |
| Xiluodu | 1733 | 400 | 32,000 | 30,000 |
| Xiangjiaba | 1600 | 533 | 85,000 | 55,000 |
| Total | 7333 | 1733 | 184,000 | 149,000 |

FIGURE 3 Slope farming and resulting erosion and land degradation processes in Dashabao, Zhaotong City. (Photo by Zhang Baiping)



ing national policy and the orders of higher administrative authorities. There is a saying in the local areas about the projects: “The country will get achievement, the enterprises will get benefits, the local government will get difficulties, and resettled migrants will get poverty.”

Environmental impacts

Ecologically speaking, Zhaotong City is rather fragile due to its mountainous terrain (mountains occupy over 97% of the

FIGURE 4 Environmental impacts of hydro-project road building in Zhaotong City. (Photo by Zhang Baiping)



land surface), steep slopes (nearly half the land has gradients higher than 25°), high precipitation (over 1000 mm), and widespread cultivation on sloping land (more than 70% of its farmland is on steep mountain slopes). This has induced serious soil erosion (Figure 3). More than half (52%) of the land surface suffers from soil loss, and 57% of the area affected has heavy ($5000\text{--}8000\text{ t/km}^2$) or moderate ($2500\text{--}5000\text{ t/km}^2$) degrees of soil erosion.

Hydropower projects inundate high-quality farmland in the valleys (Table 2), i.e. the best farmland with the favorable climatic conditions of the city. This necessarily leads to reclamation of farmland on mountain slopes, which have to be much greater in area than the land inundated in valleys in order to provide enough food for the large and still growing population. This undoubtedly means more serious soil erosion.

Moreover, the construction of dams and storage of large bodies of water in reservoirs can trigger geological disasters such as landslides and debris flows. In such a mountainous region, the construction of roads for the transportation of materials needed by the projects necessarily undermines slope stability (Figure 4) and induces landslides and more serious soil erosion.

Coordinating hydropower development and regional development

From this it can be concluded that serious tensions exist between hydropower development and regional development. The hydropower enterprise—the Three Gorges Corporation—is state-owned, and only discusses issues with provincial leaders. The Zhaotong City and lower local governments have no rights in relevant decision-making. They cannot be sure how much they will benefit from the production of hydroelectric energy from these projects. There is widespread concern that, although the hydropower stations are as modern as those in Europe, the residents will become as poor as people in Africa.

The local government and residents have a clear responsibility but uncertain

interests. The local governments and residents above all face many responsibilities related to displacement of residents before the start of the projects (Figure 5), and protecting the environment of reservoir areas afterwards. But what about the interests of the local residents and the region? Their responsibilities are clear and must be taken, while their interests are only theoretical and uncertain.

There is thus a potential for social conflict. Low levels of compensation make people complain, usually about the local government. It has been reported that serious conflicts have taken place at some dam-building sites in recent years in southwest China. Although China has experience of and has learned lessons from resettling people in the Three Gorges dam area, social conflict seems to be unavoidable between those who will be displaced, local governments, and hydroelectric enterprises.

A new approach to the dilemma

The following proposals have been fully considered and put forward by the Zhaotong Commission on Development and Reform and the authors, so as to coordinate hydropower development and regional development, especially to integrate local needs in the overall hydropower development scheme in the upper reaches of the Yangtze River. The government of Zhaotong City has submitted these policy suggestions to the government of Yunnan Province, with a view to having them considered and implemented by the State Council in the near future:

1. *Draw up new regulations for resettling people in the upper Yangtze River.*

China issued exclusive regulations for the resettlement of people affected by the Three Gorges project, which effectively helped solve problems raised in

FIGURE 5 Resettlement of the rural population in areas such as this traditionally farmed landscape along the Jinsha River will cause social conflicts, especially as the local and district governments have little decision-making power vis-à-vis the state and the hydropower company. This calls for change at the policy level. (Photo by Zhang Baiping)



the process of resettlement. People in the upper Yangtze River area, however, are to be compensated according to the criteria set in the *Regulations Regarding Land Confiscation Compensation and Migrant Resettlement for Large- and Medium-Scale Water Conservancy and Hydroelectric Projects*, which was drafted based on the 1986 Land Law of China and issued in 1991 by the State Council. This Regulation was drawn up at the time of the planned economy and is obviously outdated. Without proper dam resettlement regulations, arranging resettlement poses a grim challenge to local governments, while benefits for migrants cannot be guaranteed.

2. *Make a general plan for hydropower development and regional development in the upper reaches of the Yangtze River.*

This plan should be formulated jointly by the central government, the state-owned hydropower enterprise, the provincial government, and local governments. It would be best to take into account the views of the local people. This plan must have multiple objectives, particularly with regard to poverty alleviation, ecological restoration, and local economic development. In brief, hydropower development should be coordinated with local mountain development.

Dam building is a social question as well as an economic one. Broad-based inclusion of stakeholders in decision-making about hydropower development may slow down the process, but it leads to more perceived equity and acceptability for large-scale projects

that radically transform people's lives and environment.

The local government hopes that the hydropower enterprise can consider fully connecting the project-specific road with the local road to form a continuous system in the region, especially along the lower Jinsha River, for future use. It also hopes that the project will use local materials to the greatest possible extent, and, most importantly, that the enterprise will employ as many local workers as can be trained during construction of the dams and can work in other areas or for other hydropower projects in the future.

3. The upper Yangtze River region, especially the lower reaches of the Jinsha River, is the main ecological defense or ecology-controlling pivot of China's most developed economic center (the lower Yangtze River delta region) and its greatest hydroelectric project (the Three Gorges project). To some extent, they are a national ecological defense. Only if the central government can resolve the interacting problems of poverty and ecological fragility in this region can ecological defense be built and protected. It is thus strongly suggested that the lower reaches of the Jinsha River be delimited as a special national eco-district. Sustained ecological compensation should be provided to this national eco-district, which, as a payback, could engage in "green" production and provide ecological security for the lower reaches of the Yangtze River and the large-scale dams on the river.

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