Construction of massive hydropower schemes affects natural conservation in the lower Jinshajiang region

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By

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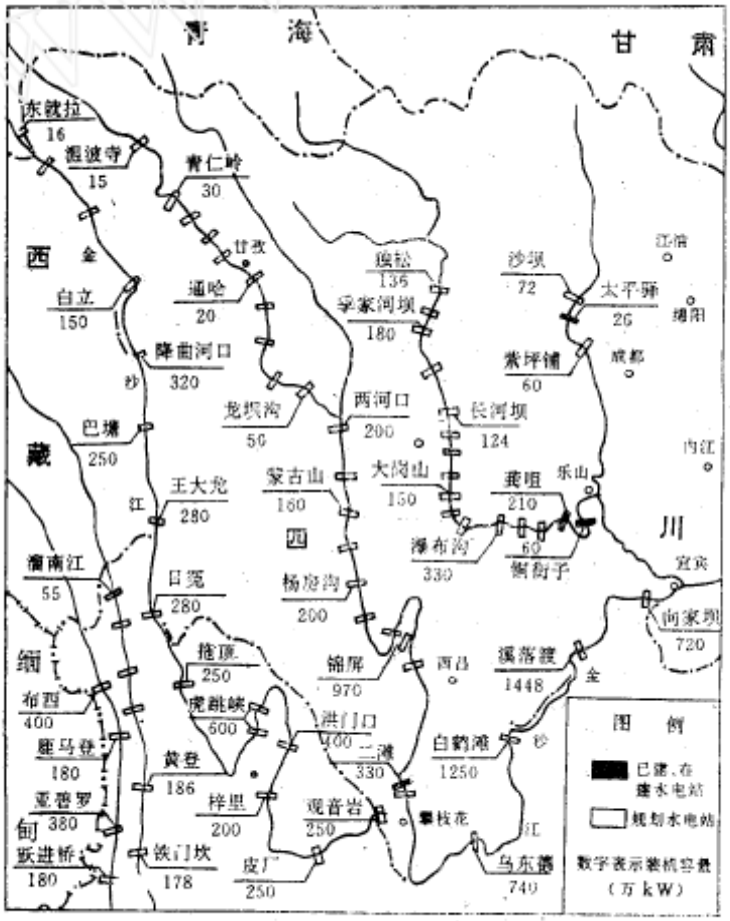
1. Introduction

With fast economic development in China in the past three decades, the energy consumption has increased quickly as well. The requirement for energy, especially electricity has increased considerably and nearly 70% of China's primary energy consumption is met with coal, which has had enormous environmental impacts. Therefore, alternative energy that has low environmental impacts like hydroelectricity has been given high priority. Installation of new hydroelectricity facilities has increased greatly in the past two decades and this trend of fast development is estimated to remain for another ten to twenty years.

While hydroelectricity has contributed considerably to economic development and reduction of coal consumption, many people have also questioned the necessity of these hydropower projects. The main concerns include the impacts of construction of hydroelectricity facilities on environment and biodiversity conservation. Since environmental impact assessment repots of many hydroelectricity projects are not accessible to public, people do not know to what extent and how a specific hydroelectricity project will affect the local environment and biodiversity. We have also realized that most institutions that are responsible for environmental impact assessment do not have appropriate expertise on biodiversity conservation. Few such institutions have manpower of biological sciences. Therefore, the quality of such assessment is questionable and information about flora, fauna and vegetation is often cited from previous publications. Probably only one project in China, the Three Gorges Project, received appropriate attention due to various reasons and a great deal of biodiversity related work was carried out in the Three Gorges Project region. Unfortunately, limited attention has been paid to other similar, huge projects.

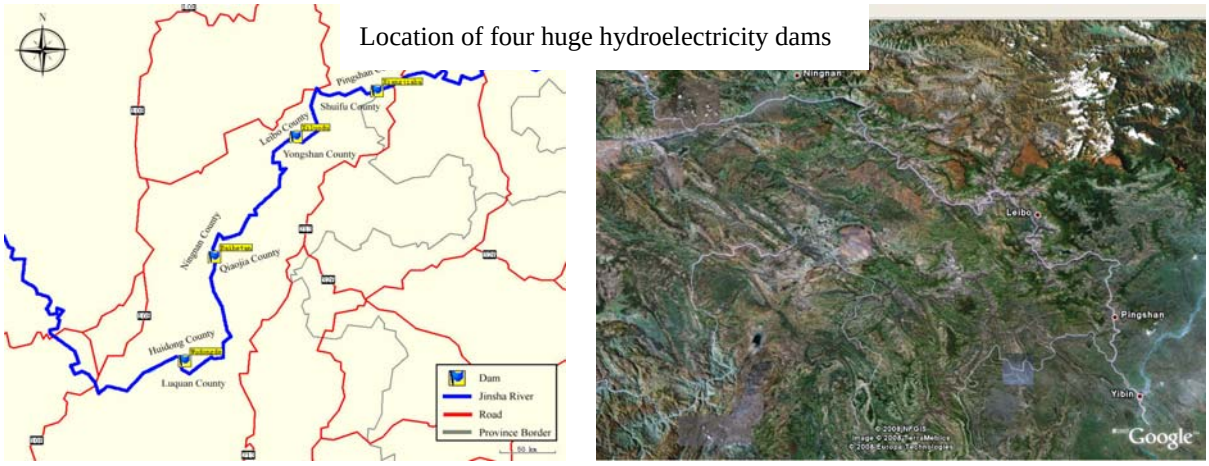


Hydroelectricity plants planned on Jinshajiang

The Jinshajiang River ("*Jiang*" is for river in Chinese) is the main upper reaches of the

Changjiang (the Yangtze River). It is around 2300 km long, starting from Yushu of Qinghai Province to Yibin of Sichuan Province. It has many tributaries and the major ones include the Yalongjiang, the Minjiang, and the Longchuanjiang, etc. The altitudinal difference within the length of the Jinshajiang is over 3000 m, namely it declines over 1 m in 1 km. The Jinshajiang basin is therefore regarded the best region with huge hydroelectricity potentials in China. The potential capacity of hydroelectricity is 112400 million watt (MW), accounting for around 20% of the total potential capacity of hydroelectricity in China, and the exploitable hydroelectricity is 90000 MW, accounting for over 42% of the whole Yangtze basin. As many as 18 huge hydroelectricity dams have been planned along the Jinshajiang and some have been constructed or under construction.

Of the whole Jinshajiang, the lower reaches are the most important in hydroelectricity exploitation. The lower reaches of the Jinshajiang start from Jinjiang where a large tributary of the Jinshajiang, the Yalongjiang, joins it, to Yibin where the Minjiang, another large tributary of Jinshajiang, joins it. The lower reaches cover a distance of 789 km and is regarded as a “gold region” of hydroelectricity and four huge hydro-electricity schemes, namely, Xiangjiaba, Xiluodu, Baihetan and Wudongde, have been planned. The total capacity of hydroelectricity of these four projects is 42460 MW, accounting for 47% of the

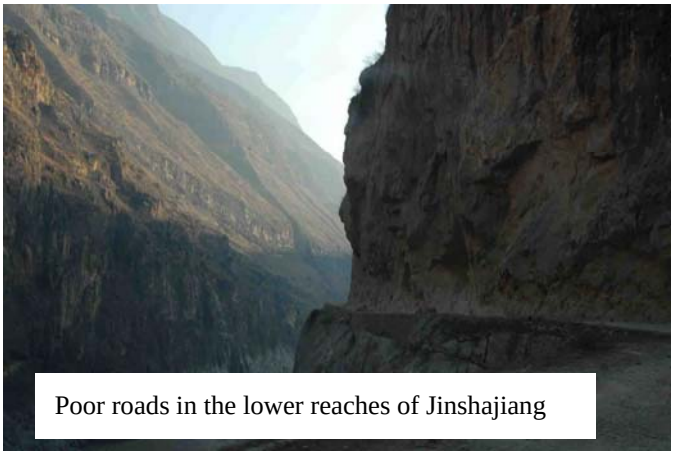


Location of four huge hydroelectricity dams

hydroelectricity capacity of the Jinshajiang. Construction of Xiluodu and Xiangjiaba has started in 2005 and 2007, respectively. Construction of Baihetan is expected to start in 2010 and construction of Dudongde is expected to start in less than 10 years.

There is no information available about impacts of these huge projects on nature conservation, especially biodiversity conservation. Therefore, sponsored by the Rufford Small Grants Foundation of the United Kingdom, a preliminary survey was carried out during February 2008, covering three hydroelectricity projects (Xiangjiaba, Xiloudu and Baihetan). A field investigation was carried out for detailed collection of plants during April to May 2008. This was the driest season of the year with little rainfall, during which few field botanical collections had been organized before. The investigation included collection of plant specimens in the areas subject to submerge by the hydroelectricity reservoirs and other related information in the region. The field survey and collection started from Xiangjiaba, the

hydroelectricity dam site at the lowest altitude among the four massive hydroelectricity projects, went up along the Jinshajiang River, through Xiluodu, Baihetan, to Dasongshu where the dam of Wudongde hydroelectricity site is located. We did not go further up to the highest elevation where the Wudongde reservoir will reach. The point from which we started collection of plant specimens was at 28.65^0 N and 104.4^0 E with an altitude of 282 m asl and the last point on the river was at 26.33^0 N and 102.63^0 E with an altitude of 929m. The two surveys covered a total of around 7960 km, 2100 km during February and 5860 km during the April-May 2008. Roads in some places are extremely narrow on cliffs. Three persons participated in the February and seven people participated in the April-May survey.

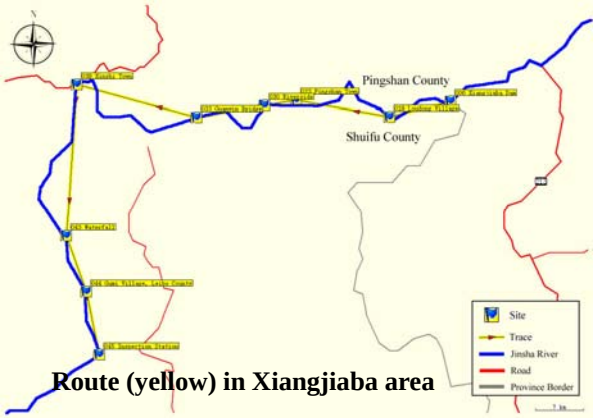


Poor roads in the lower reaches of Jinshajiang

In July to August, a third field investigation was carried out in order to collect those which were not flowering or fruiting or did not emerge during the second investigation. The third survey was financially supported by the Foundation Franklinia of Belgium, covering almost the same areas, except for the upper part to Dasongshu which was not accessible due to road blocks resulted from heavy summer rains. Seven people participated in this survey. This report covers the results of these three investigations. In total, 2292 specimens were collected.

2. The region

Topographically the lower reaches of the Jinshajiang River are characterized by high mountains, steep slopes, and narrow but deeply dissected valleys. As a result of combined rain shadow and foehn wind, the climate in the valley is dry and the valley is classified as so-called dry valleys (Zhang, 1992; Tang et al., 2004) or more commonly called as hot-dry valleys. The altitudinal range of the dry valleys is usually to 300-1000 m up from the river. Most of the areas along the valleys have been utilized for agricultural production, but there are still patches with small natural habitats left.

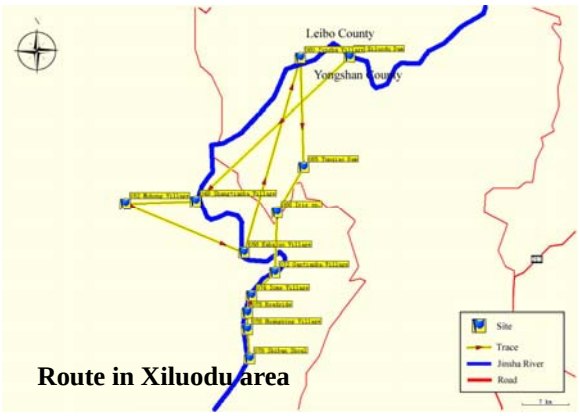


Route (yellow) in Xiangjiaba area

Landscape in the dry valley of the lower Jinshajiang

2.1 Climate

Typically, the climate in the lower Jinshajiang valleys is hot and dry. Temperature is higher



Route in Xiluodu area

Route in Baihetan area

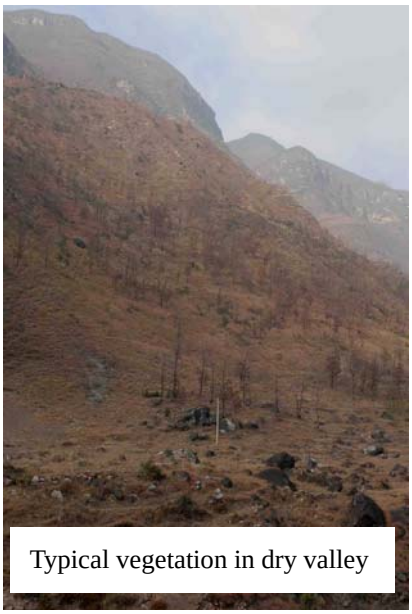
than their neighboring areas and the mean annual temperature ranges from 20 to 27. 8^0C. Rainfall is lower than their neighboring areas and the areas at a higher elevation. Annual precipitation is 600 – 800 mm and its seasonal distribution is uneven. The rainfall during the raining season from late May to October usually accounts for 80-90% of the total annual precipitation and the dry season receives only around 10-20% of annual rainfall. The potential evaporation is approximately three to six times as great as the precipitation. As a result, the habitats in the valleys are “hot and dry”.

2.2 Soil

Soils are mostly classified as dry red soil or red soil. Due to considerable altitudinal difference and steep slopes, land slide and debris flow are frequent. Soil erosion is severe and most soils are already washed out. Soils are usually shallow and poor in nutrients. Gravels are common, accounting for as high as 50-70% in some places. As a result, soils are poor in water holding and nutrient holding capacity.

2.3 Vegetation

Strikingly different from dense shrubland or evergreen subtropical forests at higher altitude of the valleys, the vegetation in the dry valley is poor, characterized by sparse grasses and shrubs with scattered small trees, and is referred to as a special type of semi-savanna or savanna of valley-type (Jin et al., 1994; Ou & Jin, 1996). Vegetation becomes better with increase in rainfall and moisture in small patches in some places. In general, vegetation is difficult to restore after destruction, mainly due to loss of soil and degraded habitats.



Typical vegetation in dry valley

2.4 Socio-economy

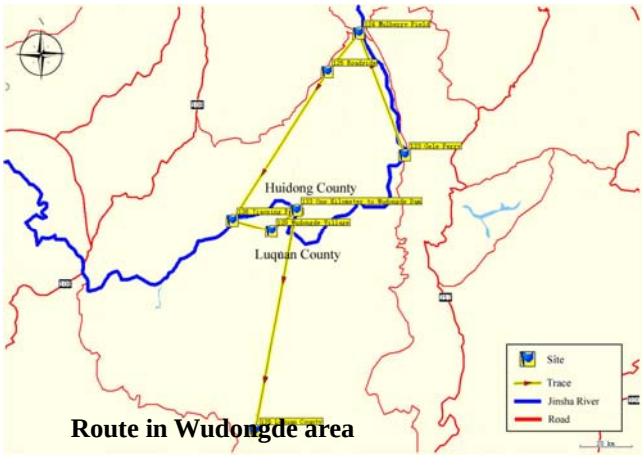
Most areas in the lower Jinshajiang region were not accessible until recently, with only poor roads constructed. Economy in the region is poor and most population is

below national or provincial poverty lines. In addition, Yi Minority Nationality constitutes a large portion of local population and is dominant in the valleys from Xiluodu to Baihetan. Modernization is low in these areas. Agriculture is the major economic activities for the local population. In addition, mining is common in several places, which causes severe soil erosion and potential environmental risks to the lower reach areas.

3. Massive hydropower schemes in the lower reaches of the Jinshajiang River

The Jinshajiang is the upper reach of the Yangtze River, from Yushu of Qinghai Province to Yibin of Sichuan Province. It is around 2300 km long, flowing through Qinghai, Tibet Autonomous Region (TAR), Sichuan and Yunnan. The part from Yushu of Qinghai to Shigu of Yunnan is called the upper reaches, from Shigu to Jinjiang of Sichuan the middle reaches, and from Jinjiang to Yibin the lower reaches. The present project focuses on the lower reaches. It is around 800 km long from Jinjiang to Yibin.

Four massive hydropower schemes have been planned in the lower reaches of the Jinshajiang region. Two of them are being constructed, and the third one (Baihetan) is expected to start in 2010. The total capacity of the four schemes, based on the latest information, is 42460 MW, 2.3 times of the Three Gorge Hydropower project (Table 1). According to our field investigation, there is about 2-3 km from the end of Xiangjiaba reservoir to the dam of Xiluodu and but there is no distance from the end of reservoirs and dams in the remaining three reservoirs. They are therefore all connected by water. The completion of the four huge hydroelectricity schemes will created a 800 km long reservoir.



Route in Wudongde area

Table 1. Basic information of the four massive hydroelectricity projects in the lower reaches of the Jinshajiang

	Xiangjiaba	Xiluodu	Baihetan	Wudongde
Dam height (m)	162	278	289	240
Elevation at dam top (m)	384	610	834	960
Reservoir level (m)	380	600	825	975
Electricity capacity (MW)	6000	12600	14000	8400
Reservoir volume (100 m m^3)	51.63	126.7	190	42.2
Reservoir length (km)	157	198	184	245.7
Reservoir surface area (km^2)	95.6	140	216.9	NA
Annual pan-evaporation (mm)	1500	2400	2600	2500
Estimated water loss to evaporation (m^3)				

Sources: Collated from information available in the internet.

4. Flora

The most important output of these two projects is a checklist of seed plants collected from the hot and dry valleys. Based on the two field surveys and complemented by literature, the flora in the valley areas subject to be submerged by the hydroelectricity reservoirs consists of around 540 species in 349 genera and 108 families. There are still some more specimens not yet identified. It is estimated that the total number of species of the area may be around 600


Hibiscus aridicola


Terminalia franchetii var. *glabra*

species. Gramineae and Papilionaceae are the two families with the highest species number, followed by Compositae, Euphorbiaceae, Rosaceae, Verbenaceae, Ranunculaceae, Urtiaceae, Malvaceae and Labiatae. Some species, such as *Illigera cordata* var. *mollissima, Terminalia franchetii* var. *glabra, Combretum wallichii, Alstonia mairei, Hibiscus aridicola, etc*., are distributed mainly in the dry and hot habitats. Population of many species is small. The population of some species, like *Terminalia franchetii* var. *glabra, Nouelia insignis, etc.* consisted of only a few trees and only two trees of an unidentified small tree of Rubiaceae was found.

From a floristical point of view, the flora in the valleys is characterized by rich tropical elements, such as *Heteropogon, Bothriochloa, Dodonaea, Barleria, Indigofera, Phyllanthus, Calotropis, Arthraxon, Cympogon, Eulaliopsis, Dichanthium, Grewia,* and *Excoecaria*. The habitats, therefore, are the exclave of tropics and southern subtropics. In addition, some tropical fruit trees, including mango, banana, litchi, longan, pineapple, papaya, are commonly cultivated in the valleys.

5. Impacts of hydroelectricity projects on biodiversity conservation

5.1 Loss of habitats

The first significant consequence of these massive hydroelectricity projects is the loss of large areas of habitats submerged by reservoirs. As mentioned previously, the unique habitat of the hot-dry valley is basically limited to about 300-1000 m up from river. The height of these reservoirs ranges from 162 m at Xiangjiaba to 289 m at Baihetan (Table 1), which indicates that the habitats of the most characteristically dry and hot nature will lose with construction of these reservoirs. Due to the lack of information and data, we could not calculate the areas submerged by the reservoirs. Since almost all the river valley from Xiangjiaba to Panzhihua, a

distance of around 800 km, will be submerged by the four reservoirs, the areas might be considerable. In addition to the areas directly lost due to submerging of reservoirs, construction of the four massive hydropower projects will also take large land areas: (1) almost all the existing roads will be lost and new highways and roads need to be constructed, which occupies large area of land; (2) residential areas for the construction workers will also take lots of land; (3) although some local people will be resettled in other counties, most of the local population from the submerge areas will be resettled locally, which will again take large land areas for their housing, agriculture, etc. Loss of these lands is loss of habitats, which will definitely cause loss of many plant species from these areas. Some species would become extinct.

Wild *Firmiana simplex*

During our field investigation we found that some patches that will be submerged by reservoirs have a good number of species. In a patch of around 2000 m^2, around 40 species were found (Box 1). However, most of these patches close to the Jinshajiang River will be submerged and all these plants will be lost. Apart from loss of habitats, construction of the massive reservoirs will also caused more fragmented of habitats. Species becomes more scattered in distribution.

Habitat loss and fragmentation have recognized as the major threats to biodiversity conservation. Habitat loss will cause disappearance of many species from the valleys and habitat fragmentation will exaggerate the risk of the species loss. Unfortunately, there is no plan for ex situ conservation of plants that will be lost due to habitat loss, mainly because there was no detailed botanical expedition during the environmental impact assessment of these projects. Measures are taken only for the protected species listed by the Ministry of Environmental Protection.

Jatropha curcas, a biodiesel producing tree in dry valle

Illigera cordata var. *mollissima* in dry valleys

Box 1: Around 40 species were found in a river bank patch.

The main species were:
Viburnum sp., *Salix* sp., *Ficus pyriformis, Ficus tikoua, Rosa* sp., *Osteomeles schwerinae, Sorphora viciifolia, Clematis chinensis, Clematis aff. Finetiana, Indigofera* sp. *Polygonum suffultum, Anaphalis* sp., *Campylotropis hirtella, Lespedeza* sp., *Elaeagnus umbellata, Arthraxon lanceolatus, Senecio* sp., *Polygonum sagittatum L., Barleria cristata, Pyracantha fortuneana, Sorbus* sp., *Flemingia macrophylla, Vitex negundao, Coriaria nepalensis, Ricinus communis*, Vitaceae sp. 1, grass species 1, grass species 2, Rubiaceae sp. 1, Rosaceae sp. 1 and sp. 2, Polygonaceae sp. 1, Caryophyllacecae sp. 1, Compositae sp. 1, Labiaetae sp. 1, unidentified.

5.2 Changes in microhabitat nature

Another significant impact is potential changes in microhabitat. The valleys are dry due to low rainfall, high potential evapotranspiration and high air temperature. When the four reservoirs are constructed, the surface evaporation of the reservoirs will be continuous and large quantity of water will be lost to evaporation, which will affect humidity of local habitats. Due to increased evapotranspiration, the local dry (arid to semi-arid) valley might change to semi-arid or semi-humid valleys. This trend has been observed in Panzhihua. Panzhihua is just a few kilometers up from Jinjiang where the lower reaches of the Jiangshajiang River starts. The climate is of typical dry and hot type. The Ertan Hydropower Plant, one massive hydroelectricity project around 46 km from Panzhihua, was completed around 10 years ago. The dry and hot nature of the valleys has changed and local residents have also reported more frequent rainfall events. In addition, changes in humidity may also cause changes in air temperature. The combined effects of these changes will affect growth and movement of local species. However, the changes will be so fast that many species may not be able to adapt to the new habitats before disappearance from the region.


Aleuteris fordii, tung oil tree


Quercus cocciferoides, a low altitude oak

5.3 Alien species

Collecting *Terminalia*

These areas were not easily accessible to outsiders until recently. Therefore, alien species have not become a big problem until recently. With increased accessibility and frequent communication with the outside world, risk of alien species has increased considerably. Many studies have indicated that transportation and roads are the main way of alien species spread. Crofton weed (*Eupatorium adenophorium*), an alien invasive species, for instance, has spread mostly along roads, railway and highway. It is the alien species that has caused significant ecological and economic loss in the region and many other parts in southwestern China. There are also some other alien species, especially those of the Compositae and legume family. However, no assessment on the alien species has been carried out yet.

Collection in the field

Each hydroelectricity project involves a great deal of construction that needs a great deal of materials. Transportation of these materials will increase the spread risk of alien species. In addition, many of the construction technicians and workers are from other provinces and there have been frequent and large amount of people movement. Each of these four projects has planned a large area of residential site. Considerable efforts have been made to plan various horticultural plants, many of which are alien species. There is no ecological impact assessment of these alien species.

5.4 Habitat becoming more fragmented and pressures on local land resources increased

Submerge of large areas in the valley will affect considerably the livelihood of local people. Based on the field surveys, the valley has developed into important bases of specificity agricultural products, which are the most important sources of income for local communities. These specificity products include ponggan (a variety of organe) and longan in the Xiangjiaba reservoir areas, oval orange and green huajiao in the Xiluodu reservoir areas, sericulture and

sugarcane in the Baihetan reservoir areas.

In the Xiluodu Hydropower Project area, for instance, a special variety of oval orange is produced at a specific location. This variety is so special that no other places seem be the similar in producing this variety. The oval oranges are all booked and the growers sell their products in their own farm because all the buyers come to their farm. The income of 1/15 ha of land is around 15,000 to 30,000 RMB yuan (US$ 2000-4000), while income for food crops like rice and wheat is around 1500 yuan only. However, around 60% of the cultivation will be submerged by the reservoir. Resettlement of local people is another difficult issue. According to the government regulations, the living standard of the resettled people should not lower than the level before resettlement. Two options are used in resettling local population subject to submerge. One is to move them to other counties in the same prefecture. Some people will be moved to Xichang, Dechang and Xide counties of Liangshan Prefecture. The survey in these areas, however, has indicated that the income of local farmers in these counties is only about 1/3 or 1/5 of the people in Xiluodu project areas. Local communities in the Xiluodu areas are not willing to move. The second way of resettlement is so called “upward resettlement”. Local communities are asked to move to higher altitude which will not be submerged by the reservoir. Problem with this resettlement is that usually less land is available in places at higher altitude. Even if there is land available, its quality is poor compared with those at the lower altitude.

Survey has indicated that local people are not willing to move! But they have no other choices and they have to move to other places. The implication of this resettlement to nature conservation lies in a number of fields. First, the unique habitat for some plants and wildlife will lose for ever. Secondly, with the resettlement of local people at higher elevation, to support their livelihoods, they have to expand their agricultural activities to the land which is not suitable for farming, which will cause severe soil erosion and increase landslide risk.

Interview of local people

The second important cash crop that will be mostly lost to reservoir is so-called qinghuajiao, or green huajiao. This is a local special which is most widely used in Sichuan cuisines. This region along the Jinsha River produces the best quality qinghuajiao, and around 1 million mu qinghuajiao are cultivated in the region. Two counties on the river side will be affected mostly:

Leibo and Jinyang in Sichuan, Yongshan and Qiaojia in Yunnan.


Collection in the field


Grewia braychyponda, a dry habitat species

6. Future actions

The valley in the lower reaches of the Jinshajiang is classified as dry valley and form a very distinct landscape. This is a special habitat that support specific flora. Due to topographical effects, there is a belt of around 300-1000 altitudinal range that receives much less rainfall but with higher temperature. Vegetation in this belt is poor and is desert-type, characterized by lack of trees and sparse shrubs and herbaceous plants. This area is actually a climate "exclave" because its climate is so different from its neighboring areas. As a result, flora is also very different. However, with construction of the four huge hydroelectricity plants, a large area of the specific habitat will lose to reservoirs and a roughly 800 km long reservoir will facilitate large amount water evaporation, which will affect local dry habitat. The impact of these changes in environment on local flora is unclear.

Our surveys reveal that a specific flora has developed in the lower reaches of the Jinshajiang and many species may become rare, endangered or extinct. Unfortunately, no measures have been planned for conservation of this specific flora. Because two hydroelectricity projects have been under construction and reservoirs will be formed in 2-3 years, it is urgently necessary to collect seeds and other materials as ex situ conservation measures. Therefore, we suggest that collection of seeds of plant species be planned from the autumn this year (2009).


Specimen pressing


Lunch in the field

References

Jin Zhengzhou, Ou Xiaokun, Ou Puding, Chen Jie. 1994. A preliminary study on floristic characteristics of seed plants in the dry-hot river valley of Jinshajiang. Acta Botanica Yunnanica. 16: 1-16

Ou Xiaokun, Jin Zhengzhou. 1996. A preliminary study on the flora and ecological diversity in Jinsha river dry-hot valley. Journal of Wuhan Botanical Research. 14: 318-322

Tang Ya, Xie Jiasui, and Sun Hui. 2004. Revisiting sustainable development of dry valleys in Southwest China. Journal of Mountain Research 1(1): 38-45.

Zhang Rongzhu (editor), 1992. The Dry Valleys of the Hengduan Mountains Region. Science Press, Beijing. (In Chinese)

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The July-August crew on ferry on Jinshajiang

The April-May crew in Xiaoudu