DAM CONSTRUCTION AND ENVIRONMENTAL PROTECTION OF CHINA'S ERTAN PROJECT

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Abstract

Ertan Hydropower Project, with a double-curvature arch dam of 240m high, is China's largest hydropower scheme built in the 20th century. Partly financed with the World Bank loans, the project was constructed and managed in strict accordance with international practice. Environmental management was implemented in full compliance with international standards, achieving satisfactory results. In the year of 2006, the project was awarded the title of Environment-friendly Project by the central government of China.

With a high dam and large reservoir, Ertan's environmental issues were mainly associated with the construction activities and change of the hydrological conditions of the river during project construction and operation. This paper describes and discusses the environmental impact alleviation measures carried out at Ertan, which include handling of pollution (gas, water and noise), establishment of reservoir buffer zone, control of schistosomiasis areas, downstream safety warning system, landscaping of construction areas, reservoir clearing, protection of historical and cultural relics, etc. The thesis also summarizes the monitoring results of the significant environmental elements, such as sediment, hydrology, rainfall, water quality, water temperature, meteorology, seismic activities, terrestrial life, and aquatic life.

Ertan's achievements in environment management may provide useful experience and reference to other dam projects, and help us understand environmental impacts scientifically, resolve environmental issues effectively, and exert environmental benefits adequately.

1. Introduction

Ertan Hydropower Project, located in the lower reach of the Yalong River in Panzhihua, Sichuan Province, southwest of China, is the largest hydropower scheme built in the 20th century. With a total installed capacity of 3,300 MW, the project yields an average annual power generation of 17,000 Gwh. The 240m-high double-curvature arch dam provides a reservoir capacity of 5.8 billion cubic meters, a reservoir area of 101km^2, and a reservoir length of 145km at the normal pool level of El.1,200 m.

Construction of this project was officially commenced on Sep.14, 1991, and reservoir

filling was started on May 1, 1998. The first turbine-generator unit was put on-line on Aug.18, 1998. Entire completion of the project was achieved in 2000.

The total cost of the project was 28.5 billion RMB equivalent, out of which 930 million USD equivalent of the World Bank loan was used. Due to involvement of the World Bank, the project was constructed and managed in full accordance with international practice. Environmental management was implemented in strict compliance with standards of both the World Bank and China, achieving satisfactory economical, environmental and social benefits.

A series of measures were taken to alleviate unfavorable impact on the environment, which included handling of pollutions (gas, water and noise), establishment of reservoir buffer zone, care of schistosomiasis areas, development of downstream safety alarming systems, landscaping of construction areas, clearing of the reservoir, protection of historical and cultural relics, etc. Besides, monitoring was also carried out on critical environmental factors such as rainfall, water quality, water temperature, meteorology, seismic activities, terrestrial life, and aquatic life, etc.

In May, 2001, the environmental work of Ertan was evaluated and successfully accepted by the State Environmental Protection Administration of China, and in June, 2001, it passed the inspection of the Environmental Review Group of the World Bank Mission.

2. Environmental Protection during the Construction and Operation

During the construction and operation of Ertan Dam, environmental protection measures were fully and timely carried out in strict accordance with the approved Environment Impact Assessment (EIA) and design documents. Furthermore, environmental factors which may be affected by the project were monitored for a long period. All this helped us achieve much experience and provided full and accurate data for the environmental protection work of the project.

2.1 Environmental Protection of the Construction Areas

2.1.1 Handling of Water, Air and Noise Pollution

Sewage during the construction period mainly included wastewater from the aggregate plants and domestic sewage from the labor camps. Wastewater from the aggregate plants was discharged into the river after sedimentation. Domestic sewage from the camps was sufficiently treated in sewage treatment facilities before released into the river or gullies.

Air pollution treatment was intended to reduce air-particle in the construction area. For this purpose, wet-crushing system was adopted for aggregate production, and the roads were water-sprayed at appropriate intervals. In the quarry, other watering devices were used in addition to spray trucks. At the same time, low-exhaust machinery was used to reduce the pollutant concentration such as CO and NO.

For noise reduction, low-noise equipment and vehicles were used. Meanwhile,

personal protective devices were provided to the construction people, such as earplugs and/or earmuffs.

2.1.2 Treatment of Spoil Disposal Areas

There were three major spoil areas during the construction period of Ertan. With regard to different geographical contours and hydrological features, temporary measures were taken by the contractors to protect the disposal areas, such as provision of drainage facilities, slope protection by means of gabions, and use of low-gradient slopes.

2.1.3 Landscaping of Affected Sites

The construction affected sites included three construction areas, four camps and a quarry.

In one of the construction areas and two of the camps, facilities were dismantled and the areas have been reforested; the other two construction sites have been handed over to the local government for further use of the facilities; the other two camps are used respectively as a tourism facility and service area of the power plant.

At the quarry, as the quarrying process went on, slope support was carried out by use of random rock bolts. In areas deemed necessary, systematic rock bolts and small anchors were installed.

2.2 Biodiversity Protection

2.2.1 Reservoir Buffer Zone

To improve water and soil conservation and the ecological environment around the reservoir, a buffer zone was established around it. Totally, 240.3hm^2 demonstration of forest was established, with a survival ratio of 90%.

Success of the demonstration forest resolved technical difficulties and promoted the forestation work in the surrounding counties. From 1998 to 2000, about 1,000 hm^2 of seedlings were planted.

Besides tree planting, a number of areas have been defined as special zones limiting human activities for the purpose of forest protection. The establishment of Ertan Scenery Administration has also contributed to protection of the vegetation around the reservoir.

2.2.2 Protection of Fish Resources

Caused by the dam obstruction and change of water condition, fish resources and varieties in the reservoir changed to a certain extent. To restore the fish resources and relieve the impact, 4.2 million different kinds of fish fry were put into the reservoir, including schizothorax, Spinibarbus sinensis, Onychostoma sismus, Silurus soldatovi meridionalis Chen, Aristichthys Oshima, Cyprinus carpio, C.auratus auratus, etc. which greatly improved the fish resources.

2.3 Schistosomiasis Control

One of the counties in the reservoir area used to be an endemic area of schistosomiasis. To prevent possible reoccurrence of schistosomiasis, lots of effort was made to investigate existence of schistosomiasis and snails, and corresponding measures have been taken. Since treatment of the area was completed, the Public Health Bureau of the county has confirmed that no new cases of schistosomiasis have been reported.

2.4 Establishment of Downstream Warning System

During peak-load regulating operation or flood release, the downstream water level would change considerably in a short time. To ensure safety of the downstream residents, a warning system has been established, which consists of siren alarm, car patrol alarm, telephone alarm, and sign alarm.

The warning system has been working very effectively. Even in case of emergency flood discharge, there is sufficient time for people to leave the river course before the water level rises. No loss of human lives or property has ever been resulted from failure of the alarm system.

2.5 Reservoir Clearing

To avoid unfavourable effects caused by reservoir impoundment, all trees, houses and other structures, and waste disposals in the reservoir area were cleared out.

The clearing work was completed in 1998 prior to the initial filling of the reservoir. Up to now, there is no unfavourable impact on water quality.

2.6 Discovery and Protection of Cultural Relics

According to relevant laws and regulations, careful investigation, disentombing and relocation of cultural relics were performed.

The work was started in March, 1997, and completed prior to reservoir filling in April, 1998. All the unearthed articles are now kept in a special room.

Study of the cultural relics has helped understand human habitation in this area thousands of years ago. Discovery of bronze ware indicates that human activity in this area was much earlier than previously deemed. Future study of the relics and investigation of other sites adjacent to the Ertan Reservoir provides a much clearer understanding of the early history of human civilization in the southwest of Sichuan.

2.7 Environment Monitoring

Environmental monitoring was carried out during the construction period, which covered meteorology, water quality, water temperature, terrestrial life, and aquatic life. Some of the monitoring items have been carried over into the operation period. Environment monitoring was not only necessary for understanding of the environmental conditions in the project area, but also provided valuable data for comparing and analyzing the changes of environmental factors before and after the project

construction.

2.7.1 Local Climate

Monitoring results of the reservoir area from 1998 to 2003 show that rainfall and air humidity around the reservoir have increased obviously since reservoir impoundment. These changes have improved the climatic conditions. Precipitation is evened out through the year, with less floods in the wet season yet relatively more rain in the dry season. Likewise, the ambient temperature has risen a bit in the dry season (mainly winter) and dropped a little in the wet season (mainly summer). The number of days with strong wind has decreased considerably.

2.7.2 Water Quality

According to the monitoring results from 1999 to 2000, except for the content of Mn, Cu and coliform which became slightly higher than before at the tail of the reservoir but lower in the rest of the reservoir, there had been no obvious change in the water quality parameters after filling of the reservoir.

2.7.3 Induced Earthquake and Reservoir Bank Stability

Seism and slide monitoring of 18 years before and after the reservoir filling has indicated that no abnormal seismic activity has been triggered by the reservoir. The earthquake characteristics after the reservoir filling are nearly the same as before. The monitoring results also show that the major sliding blocks on the reservoir slopes have remained stable.

2.7.4 Terrestrial Habitat

The lower reach of the Yalong River is of dry valley climate type, short of rainfall. The vegetation coverage in the valley area is small, which includes mainly boscage, grass, and some trees. After the reservoir filling, the valley climate has improved. Increase of rainfall and humidity is especially important for vegetation, so the vegetation coverage has obviously increased.

2.7.5 Fish Species

According to the fish investigation in the Ertan reservoir implemented in spring and autumn in 2002, the environmental condition at the end of reservoir had almost no change after the reservoir filling. There were many species of fish, such as schizothorax, hymenophysa curta and Sisoridae which prefer rapid flow, Cyprinus carpio and C.auratus auratus which prefer slow flow, and Silurus soldatovi meridionalis Chen which prefer living in the bottom. In the middle part of the reservoir, where the water body is deep and the flow is slow, there were lake-fishes such as Cyprinus carpio, C.auratus auratus and Aristichthys Oshima, while rush-fishes were seldom found. No bottom fishes were found in this part.

In general, after reservoir filling, fish diversity restored to the previous level, but the composition of species has changed. Rush fish or migration spawn fish has decreased, and fish species which prefer slow flow have increased.

3. Conclusion

In the ten-year construction period of Ertan, besides many technical challenges that were resolved successfully refreshing engineering records in Asia and even in the world, environmental protection work was also implemented in strict accordance with international standards, which achieved much precious practical experience and gained good reputation. In 2006, Ertan project was awarded the title of Environment-friendly Project by the central government of China.

Ertan's achievements in environment protection may provide useful experience and reference to dam construction, and help us understand environmental impacts scientifically, resolve environmental issues effectively, and exert environmental benefits adequately.