

## **Current State and Countermeasures of Hydropower Environmental Protection in China**

---- Keynote Speech at United Nations Symposium on  
Hydropower and Sustainable Development

Ladies and Gentlemen:

It is my pleasure to participate in this symposium in Beijing. At the symposium, representatives from related governmental departments, international organizations, NGOs, financial institutions and other institutions related to hydropower development and experts will discuss on the issues hydropower exploitation and sustainable development, summarize and exchange the experience on hydropower construction and management, rethink the environmental problems of hydropower projects, explore new ideas and new mechanisms for hydropower development. It is of great significance for the promotion of sound development of hydropower, the further satisfaction of the demand for energy, and promotion of socioeconomic sustainable development. In 2002, at the World Summit on Sustainable Development at Johannesburg, the international society had a debate on the sustainable development of energy, and many countries called for the diversified supply of global energy and increase of renewable energy, including hydropower. In China's Agenda 21, hydropower is also regarded as a kind of renewable energy, clean energy and the encouraged energy to exploit, which is listed in energy development strategy. In consideration of the economic and social development trend, a new idea of energy development has been established, i.e. devoting major efforts to hydropower development, optimizing development of coal power, actively developing nuclear power, and speeding up the development of new energy. At the same time, China has also enhanced the capability of solving environmental problems in the exploitation of various kinds of energy sources, and the problems left over by history step by step.

On behalf of China State Environmental Protection Administration (SEPA), I would like to introduce the current state and countermeasures of environmental protection of hydropower in China.

### **1 Current State of Hydropower Exploitation and Environmental Management in China**

China depends mainly on coal and hydropower for conventional energy resources, with hydroenergy resource second to coal, taking a very important position in China's energy structure. China's remaining total exploitable amount of hydroenergy accounts for more than 60% of conventional energy. The hydroenergy thus plays an important role in energy resources. China ranks first in the world in total hydraulic amount, including the theoretical reserve, technically exploitable amount and economically exploitable amount. Coal has for long been the leading primary energy in China, and this energy structure will not be changed for a long time in the future. Since thermal power consumes over half (?) of the coal resource, which has lead to prominent air environmental problems, hydropower is recommended as one of the alternatives. It is noted that this will put more pressure on solving the environmental problems caused by hydropower.

Since 1949, the hydropower in China has developed gradually, with the installed capacity of hydropower stations increasing from 160,000kW in 1949 to around 0.1 billion kW at present. The total installed capacity of hydropower has exceeded the US and ranks the first in the world. Compared with developed countries (70% or even near to 90%) the exploitation degree in China is low, which is not equivalent to the important position of hydraulic resource in the energy resources. It is predicted that the hydropower installed capacity will account for about 1/5 of the total power installed capacity in 2005, with the hydropower exploitation degree of nearly 20%; and the hydropower installed capacity will account for about 27% of the total power installed capacity in 2010, with the hydropower exploitation degree of nearly 30%. During the last 50 years, China has built more than 80,000 reservoirs; most of which are comprehensive water utilization projects, and only a few are pure hydropower reservoirs. According to recent statistics, about 6,000 hydropower stations have been built or under construction, with over 160 (or 2/3 of the total capacity in the country) having installed capacity of 300,000 kW, and over 200 having capacity of 50,000kW or more. We should further study the environmental problems of these hydropower stations, have a clear understanding of the environmental problems caused by water conservancy and hydropower projects, and distinguish and solve the hydropower environmental problems step by step.

From late 1970s to the present, China has established relatively comprehensive environmental management regulatory systems for construction projects. Based on the Environmental Protection Law issued in 1979 and revised in 1989, China issued the Management Method of Environmental Protection for Construction Projects and the Ordinance on Environmental Protection for Construction Projects respectively in 1986 and 1998, established the legal position and management system of environmental management for construction projects with EIA system and “Three Simultaneities” system at the cores, and clearly defined the management procedures and requirements for construction projects. Hydropower environmental protection management in China began in early 1980s, and large- and medium-hydropower construction projects were generally included in the track of environmental management in late 1980s. Relatively sound management procedure and EIA technical specifications were established at that time. In 1988, the Technical Specification on Water Conservancy and Hydropower Projects Environmental Impact Assessment was issued. In 1992, the Specification on River Basin Planning Environmental Impact Assessment was issued. In 2002, the Technical Guideline on Environmental Impact Assessment (Water Conservancy and Hydropower Engineering) was revised and issued. In addition, EIA specifications on other environmental impact factors (surface water environment, ground water environment and ecological environment) suitable for water conservancy and hydropower engineering were also issued. With the deepening of EIA research and management for hydropower exploitation construction projects, EIA systems and methods on hydrological ecology, land ecology, water environment, reservoir inundation and immigrant resettlement were gradually established.

In the Environmental Impact Assessment Law issued in 2002, the legal position of EIA was further enhanced, and the scopes of EIA were expanded to cover plans. In the complementary Environmental Impact Assessment Scopes for Plans, EIA reports are required for plans of hydropower exploitation. The EIAs for hydropower exploitation plans in the Nujiang River, the Daduhe River and the Yalongjiang River, etc. are being carried out.

## **2 Main Environmental Problems in Hydropower Exploitation**

With intensified hydropower construction, the resulting environmental problems have become more and more outstanding, which has been paid more and more attention by the society. In particular, the impacts of tiering hydropower constructions in river basins involve a wide range, complexity and a long period. Some impacts are cumulative and even irreversible. The main environmental impacts include: dam construction of hydropower reservoirs results in the alteration of hydrology and silt between upper reaches and lower reaches, the change of water environment such as water quality and water temperature in the reservoir areas and lower reaches to a certain extent; separation of flood gates and dams and change of aquatic habitats have great impacts on aquatic organisms such as fish; the impact of submergence on terrestrial plants and animals; and the environmental problems caused by production and living activities after resettlement are also important.

### **(1) Impact on Eco-environment**

After damming, water-impounding and operation of the hydropower projects, the previous river channels will be changed into section-by-section channels, leading to obvious change of hydrology and silt situations such as water flow, flow speed and water level in the natural rivers. The annual run-offs will be leveled, and the aquatic eco-environment changed obviously. Certain amount of original vegetations will be submerged due to reservoir construction and water impounding, which may lead to the disappearance of some rare plants and animals. During construction and resettlement periods, land leveling, occupation, evacuation, new cultivation of farmlands, and transformation of farmland, etc. will destruct surface vegetations and cause new water and soil erosion. Some projects may also involve natural reserves, scenic spots, water source conservation areas and other ecological sensitive areas.

### **(2) Impact on Aquatic Environment**

The construction of high dams and large reservoirs, especially reservoirs with good adjustment functions, will change the water temperature of natural rivers. The vertical water temperature before the dams will display obvious stratification phenomenon, which can keep the water temperature in the lower layer of the reservoirs at stable status of low temperature throughout the year. The tiering development of continuous high dams and large reservoirs, in particular, will make the water temperature difficult to resume to normal. The change of water temperature in river sections will have some negative impacts on aquatic organisms. In addition, hydropower exploitation of water-diversion type and mixed type, if the sluice of eco-environmental flow is not arranged, will also lead to seasonal or perennial water depletion or water reduction in the river sections with certain length. The problem of water depletion and water reduction in many water-diversion-type power stations in west Sichuan Province is serious.

The increase of water depth and decrease of water flow speed due to the damming and reservoir construction will change the self-purification capability of natural running water bodies in the river sections of the reservoir areas. Water impounding in the early stage may lead to short-term deterioration of water quality in the reservoir areas and the downstream of the dams. But for the whole water body of the reservoir area, especially those with rapid exchange of water, the possibility of eutrophication is small. Different degrees of eutrophication may occur in the local reservoir bays and reservoir ends with low speed and shallow depth. However, the over-development of aquaculture may probably lead to eutrophication. If the ecology in the reservoir areas is properly protected and the pollution sources are well controlled, the water quality in the reservoirs can be kept at relatively good level and even improved in some areas.

### (3) Environmental Impacts of Submergence and Resettlement

There are different degrees of reservoir submergence in hydropower projects, which requires resettlement of certain number of immigrants. Water impounding of the reservoirs will decrease the original farmlands, and especially in land-shortage mountainous areas, the contradiction between resettlement of immigrants and providing farmlands is very sharp. In some areas, forest destruction and reclamation at steep slopes for resettlement will lead to very serious water and soil erosion problems in the reservoir areas. The mud and stone flow and land-slide will worsen the existing serious natural ecological problems, and even lead to secondary resettlement. This is the very reason that some migrants live a poor and unstable life for a long time. If the resettlement problem is not solved properly, the local environmental quality degradation can then be resulted in. The resettlement problem in the reservoir areas is complicated, involving policy and standard, system and mechanism, economic foundation and social environment, and national customs and traditional culture, etc. Over the last several decades, the immigrant resettlement has experienced three development stages. In the first stage (before 1980s), the resettlement mainly depended on administrative measures and most of current immigration occurred in this stage. In the second stage (from 1980s to early 1990s), the resettlement depended on planning economy mode. In the third stage (after 1990s), the state adopted the measure of setting up post-supporting fund and the living status of immigrants have been somewhat improved. With the social and economic development, the resettlement policy and compensation and subsidy standards have been increased. Resettlement methods and outgoing directions have also changed from the solely local nearby resettlement to the combination of local resettlement with resettlement in different areas and other forms, gradually moving into the track of development resettlement, resettlement by laws and proper resettlement of immigrants. The situation of resettlement has been improved and the environmental impacts have decreased gradually.

### (4) Environment impacts in the Construction Period

Hydropower projects usually involve large scale and long period of construction, and a large number of construction workers and machines. In the construction process, the activities such as land occupation, quarrying, earth borrowing and waste disposal will have major impacts on surface vegetations, and the improper prevention measures may cause serious water and soil erosion. The construction disturbance can affect the habitats of some terrestrial animals. The wastewater from the production and living areas of construction can affect the surrounding water environment. The negative environmental impacts are temporary, and will gradually disappear after the construction activities are completed. Furthermore, because the design stage and construction stage have many links and long periods, and because of insufficient supervision mechanism, some environmental protection measures should be implemented in these two stages, otherwise it will be too late.

## **3 Environmental Protection Measures for Hydropower Construction in China**

From the perspective of China's energy development strategy, the renewable property of hydropower resource and the special role of hydropower in power source structure, hydropower should have certain proportion in energy development and power construction planning. It is necessary and economically and technically feasible to develop hydropower of proper scales. However, the construction of hydropower involves wide areas, complex factors and long periods and especially very outstanding eco-environmental impacts. In the past, investment was the main constraint of hydropower construction, but from now on, the environmental issues and resettlement will be the bottleneck constraining hydropower construction.

In the last two decades or more, some achievements and experience have been obtained in EIA, environmental protection in the construction period, and environmental protection of resettlement, etc. in hydropower construction in China. However many problems still need to be solved. Hydropower construction should be carried out in the mode of sustainable development, adhere to a human-centered view, and coordinate the development between human and nature. Scientific development strategy should be build up in hydropower construction. Following measures are proposed for the environmental problems in hydropower construction in China:

(1) Enhancing the understanding of the necessity of hydropower construction and hydropower environmental protection, strengthening hydropower environmental protection policy research, and establishing and improving hydropower environmental protection policies and regulations. In order to carry out environmental protection of water conservancy and hydropower construction and protect and improve the regional eco-environment, water conservancy development constructions such as dams and environmental protection should adhere to the principle of scientific planning, taking all factors into consideration, driving the advantages to minimize losses, reasonably developing, taking preventive and protective measures as priorities, combining preventive and controlling measures, compensating for the increase of reproduction and adhering to the human-centered view. It is important to adhere to developing in protection and protecting in development. The systems of “the developer protects”, “the destructor rehabilitates” and “the users pay” should be improved and implemented. Legal, economic, administrative and technical instruments should be fully used for environmental protection of hydropower construction. Planning and guidelines by classifications should be provided, according to the spirit and requirements of National Eco-environmental Protection Outline. Regions and basins with important protective values and those without rich hydraulic resources and unsuitable for development should be included into important ecological functional zones and carefully protected. Mandatory environmental protection measures should be implemented in key development areas of hydraulic resources. Researches on technical and economic policies of hydropower and hydropower environmental protection should be strengthened to reform the hydropower price and tax system, alleviate hydropower burdens, and gradually increase the input in the environmental protection. It is imperative to integrate environmental investment into construction and operation costs. The development and protection coordination mechanism and hydropower environmental protection funds for key river basins should be established to promote hydropower environmental protection.

(2) Strengthening the environmental management for hydropower construction projects at planning stage. Hydropower construction planning should not only pay attention to technical and economic conditions, such as resource development layout, scale, structure, mode and development time series, but also consider the requirements of the river basin and regional ecological protection and ecological construction. It is important to set apart necessary river sections and water flows for eco-environmental protection. Hydropower economic planning should be developed in the direction of “green” planning. Tiering power stations construction should protect rare plants and animals, and keep away from migration and spawning sites of aquatic organisms as far as possible, concentrated areas of rare plants and animals and highly polluted areas. Projects that may stop the migration channels of aquatic organisms should be strictly controlled. In the planning of hydropower development in new rivers or the modification of original plans, EIA should be carried out for the river basin and regional plans in accordance with the Environmental Impact Assessment Law, to coordinate the conflict between hydropower and water conservancy development and ecological protection and to facilitate

coordinated and sustainable development of resource exploitation and ecological protection. For other existing plans that need modification, efforts should be made to carry out preliminary environmental impact studies of the river basin. Environmental management systems of EIA and “Three Simultaneities” should be strictly abided. Projects with potential significant environmental problems, but without effective countermeasures should not be constructed or should be postponed. Post-assessment should be carried out for dam construction projects with long cumulative and potential environmental impacts after operation.

(3) Exploiting and utilizing water resource rationally. Water use demands in the upper and lower reaches and on both sides should be taken into full consideration in the construction and operation of dams. Water resource balance in the river basin should be highlighted and the principles of “determining demands based on water supply” and “guaranteeing eco-environmental water use” be adhered to in order to protect the water quality in the water-body of the river basin and prevent soil salinization. The dams should be equipped with water sluice buildings for eco-environmental water use. The base flow of water sluice should be determined according to down-stream aquatic organisms, water environmental capacity and landscape protection, as well as the requirements of water intake and navigation. The dispatching and operation schemes will be accordingly formulated.

(4) Doing well with biodiversity protection work involved in dam construction. Protective measures should be adopted for rare and endangered plants and animals to be affected according to the natural environmental status and distribution situations. For the rare and endangered migratory aquatic animals and other special aquatic animals, effective measures should be adopted, including establishing migration channels, setting up protective areas in other places or protective river sections, and creating artificial habitats, etc. Only on the basis of guaranteeing the effectiveness of the above measures, can be the projects allowed to construct. The construction of hydropower and water conservancy projects is prohibited in the core areas and buffer areas of natural reserves, and necessary ecological rehabilitation and treatment and compensation measures should be adopted for those with potential impacts on natural reserves, landscape and scenic spots and forest parks.

(5) Strengthening the environmental protection of resettlement. Resettlement should renew ideas, improve policies, enhance standards, create mechanisms, introduce science and technology and implement management. The practices of the resettlement in Dongjiang River Reservoir can be actively promoted and the remaining resettlement problems should be solved step by step. Resettlement should be integrated in the environmental management, and resettlement plans and EIAs and environmental management systems for specific resettlement projects should be implemented. The traditional “resettlement view” should be changed to ensure the balance among land resource, population and eco-environment, change simple local nearby resettlement to resettlement in a wider region, solve the problems of steep-slope reclamation and forest destruction in resettlement and make the reclaimed lands meet the ecological protection requirements, so as to make the immigrants get rid of the status of being poor and unstable for a long time and truly achieve the target of “emigrate, be stable and become rich”. The ecological protection and pollution prevention should be strengthened for moving and re-building projects in resettlement. In consideration of water quality requirements in the reservoir areas, the moving of cities and towns as well as enterprises should not only meet the requirements of “original scale, original standard and original function”, but also follow the existing national industrial policies and environmental protection policies for enterprises. Complimentary municipal wastewater treatment (WWT) and solid waste treatment facilities and their matching facilities should be constructed like the Three Gorges project with the investment for these facilities

calculated in the compensation investment. The moving and rebuilding of industrial and mineral enterprises should also meet national environmental protection policies, and pollution prevention measures should be implemented. The utilization of water surface of reservoirs should meet environmental protection requirements, such as water and soil erosion control, terrestrial and aquatic wild life protection and water quality protection in addition to engineering safety. The social impacts of resettlement should also be fully considered, and high attention should be paid to the folks and customs of ethnic groups. The protection of historic and cultural relics should also be highlighted.

(6) Strengthening environmental protection in the construction preparation and during the construction period. The potential eco-environmental impacts in the construction preparatory stage should be included in construction management. EIA reports (forms) for the preparatory engineering should be prepared in advance, which should be integrated in the complete EIA reports of the project. The construction units should include environmental protection measures in the engineering tendering documents, include the environmental protection contents in the engineering supervision in the construction stage, and implement environmental protection measures such as aquatic organism protection measures, low-temperature alleviation measures, water sluice buildings for eco-environmental water use, etc. identified in the EIAs in the environmental protection design and construction, to resolve the environmental problems in the operation stage.

(7) Actively carrying out public participation in dam construction. Dam construction units should consult the impacted population, institutions and experts for their opinions on the projects before construction. Relevant approval departments should organize public hearing activities to widely solicit public opinions so as to make decisions accordingly.

(8) Strengthening scientific researches, increasing the understanding of environmental impact rules of hydropower and developing hydropower environmental protection technologies and technologies. The operation of environmental management systems should be studied. The mechanisms for environmental protection in the operation of hydropower stations, aquatic organism protection and environmental protection of resettlement from the reservoir areas should be gradually established and improved. International communication should be strengthened to introduce foreign management experience and advanced protection technologies of river basins. The difference of hydropower development between China and other countries should be correctly understood and dealt with.

Thank you for your attention.