Lancang River Hydropower Development, Environmental Protection, and Economic Contribution

Oct. 16, 2009

Chiang Rai, Thailand

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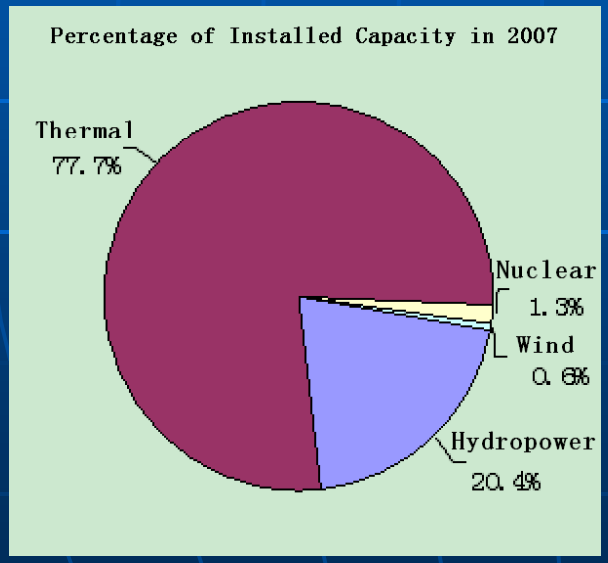
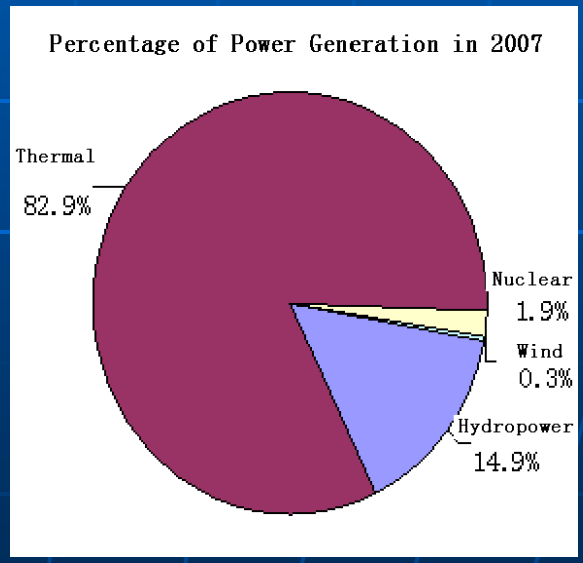
Outline

1. Hydropower Development in China
2. Hydropower planning in the Middle-Lower Lancang River
3. Strategic environmental assessment (SEA) of hydropower planning
4. Study of the eco-environmental impact of Lancang River hydropower development
5. Impounding scheme and guarantee measures of Xiaowan Reservoir
6. A case study of the contribution of hydropower construction to the development of local economy

2. Hydropower Development in China

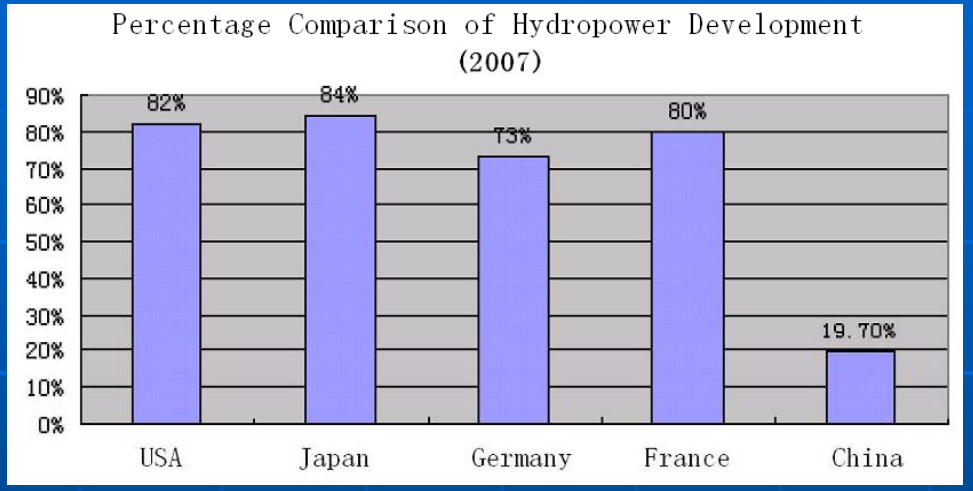
- By the end of 2007, China's installed hydropower capacity reached 145,260 MW, accounting for 20.4% of the national total, and hydropower generation reached 486.7 billion kWh, accounting for 14.9% of the total amount of power generated. It is expected that by the year 2020, the total installed power capacity of China will top 1.5 billion kW, out of which 300million kW is hydropower, accounting for 25% of the gross figure. The electricity sent by major hydropower-generating provinces in western China, such as Sichuan and Yunnan province, will reach 90,100 MW.





Hydropower Development and Greenhouse Gas Emission Reduction

- According to the results of the hydropower resource reexamination in 2003, an installed capacity of 540 million kW can be developed by hydropower technology. However, only 145 million kW was exploited till 2007, with an exploitation rate of 19.7%, lagging far behind the developed world.



- The development of hydropower is China's state policy to reduce emission of greenhouse gases and to address the global climate change.
- The hydropower output of China in 2007 was 486.7 billion kW, which equals to saving 219 million tons of raw coal and reducing the emission of 350 million tons of CO_2, 3.28 million tons of SO_2, and 69.99 million tons of dusts.
- A major step of China in spurring its energy structure to develop toward a clean and low-carbon mode is to rationally develop hydropower generation on the basis of eco-protection. On the premise of environmental protection and resettlement of local residents, China will exploit and utilize its abundant hydropower resources in a rational manner, with the focus on accelerating the hydropower development in its western region. Through the above measures, it is expected that about 500 million tons of CO_2 discharged can be reduced by 2010 (National Climate Change Program, NDRC, 2007).

2. Hydropower planning in the Middle-Lower Lancang River

The Lancang River takes its rise in the Tanggula Mountain Range on the Qinghai-Tibet Plateau in China's Qinghai province, flowing through Qinghai province, Tibet Autonomous Region and Yunnan province. It is called the Mekong River as running beyond the Chinese, traversing through Laos, Myanmar, Thailand and Cambodia till reaching Vietnam. It debouches into the South China Sea from Ho Chi Minh City, Vietnam.

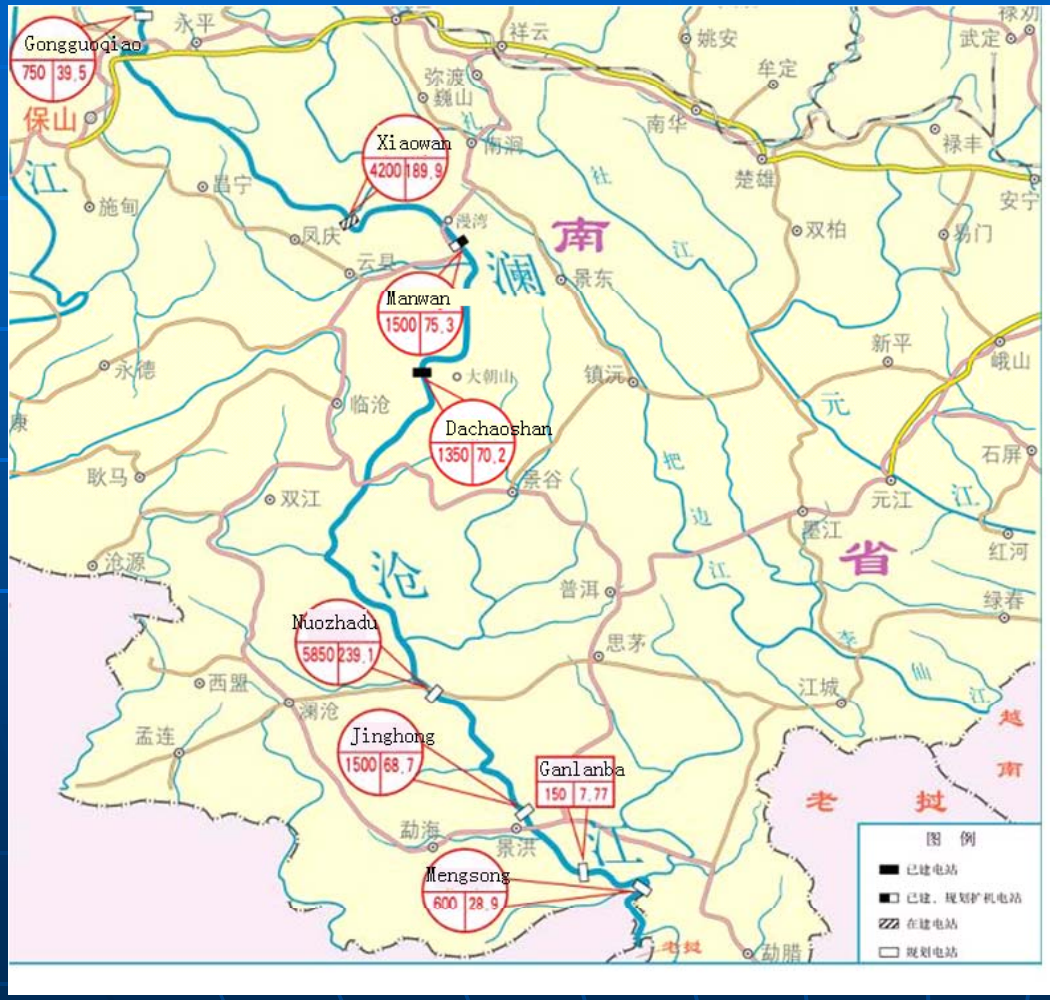
Here are main characteristics of the Lancang River:

length 2160 km,

Drainage area 740,000 km^2, covering 23.5% of the whole basin

Mean annual runoff 64 billion m^3. covering 13.5% of annual runoff at the Mekong River mouth.

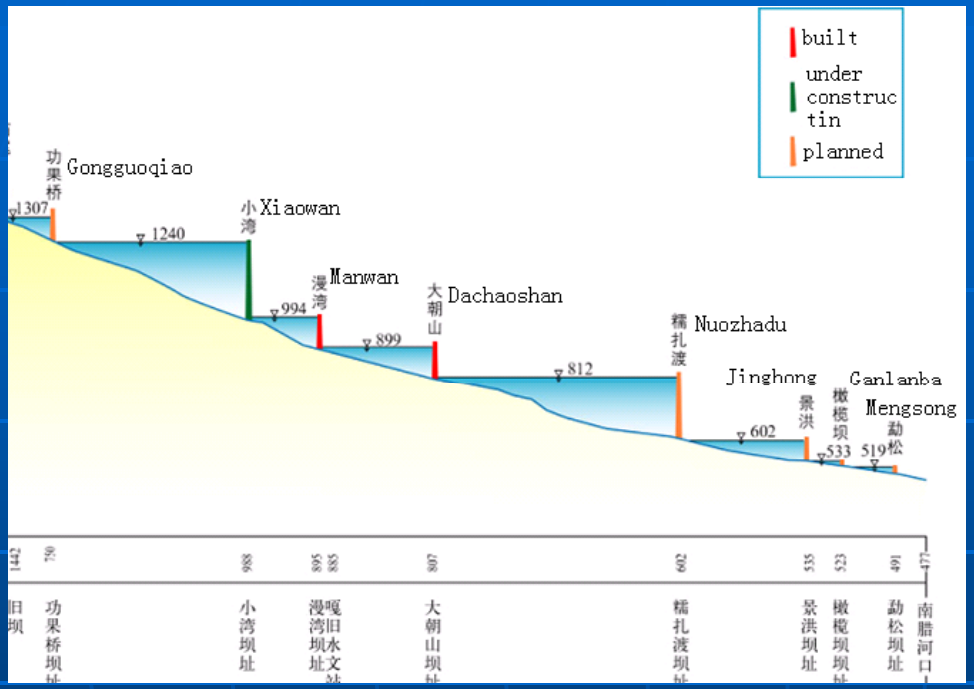
Hydropower Planning in the Middle- and Lower- Lancang River



The hydropower development planning for the middle- and lower- Lancang River passed the national examination in 1987. Eight cascades hydropower stations were planned.

- Built and put into operation:
- Manwan, Dazhaoshan, Jinghong
- Under construction:
- Xiaowan, Nuozhadu
- Planned:
- Gongguoqiao, Ganlanba, Mengsong

Hydropower Planning in the Middle- and Lower- Lancang River

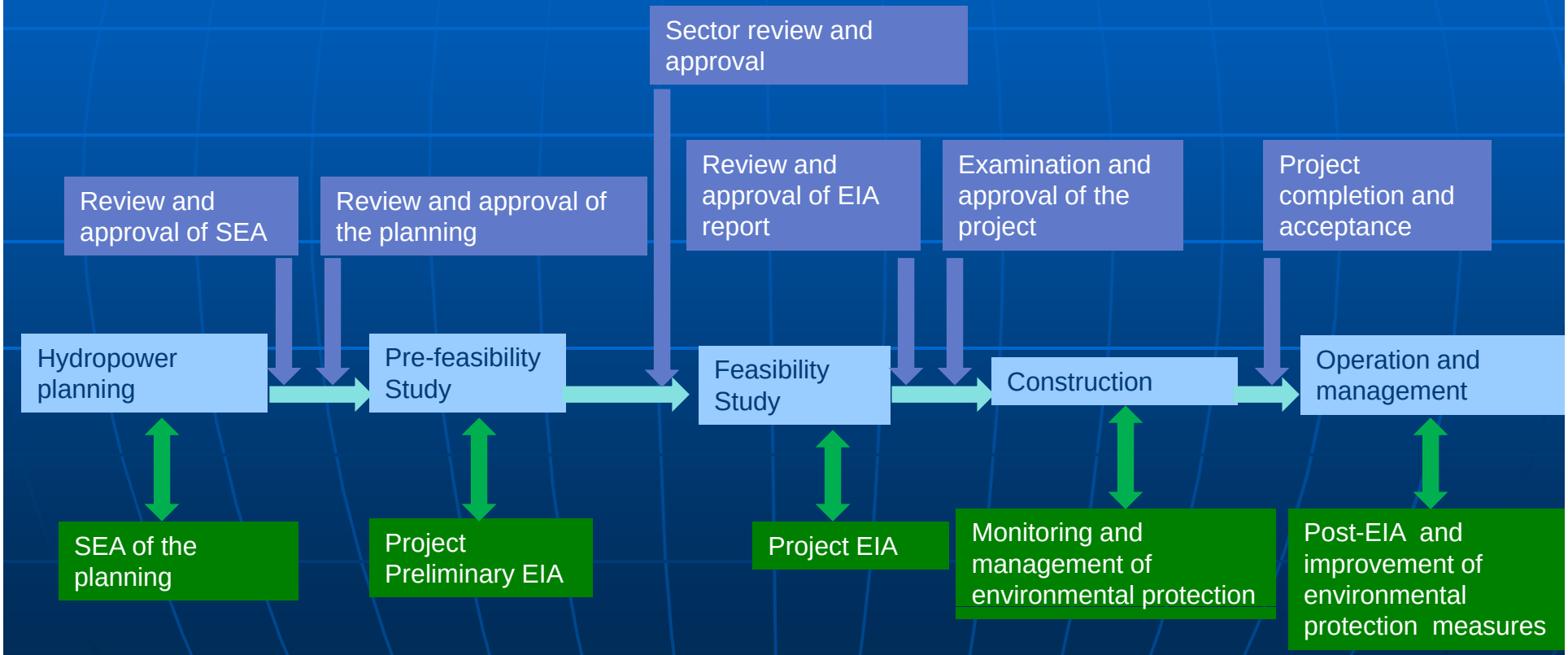


According to the planning, with Xiaowan Reservoir and Nuozhadu Reservoir as the core reservoirs, the said river segment will be developed in Gongguoqiao, Xiaowan, Manwan, Dazhaoshan, Nuozhadu, Jinghong, Ganlanba and Mengsong hydropower stations, with a total installed capacity of 15.9 million kW and annual power generation of 72.53 billion kWh.

Hydropower Station	Gongguoqao	Xiaowan	Manwan	Dazhaoshan	Nuozhadu	JIngjue	Ganlanba	Mengsong
Status	Planned	Under Construction	built	built	Under Construction	built	Planned	Planned
Distance to the Nanla River Mouth (km)	750	582	522	420	210	102	75	28
Normal Water Level（ m ）	1319	1240	994	899	812	602	533	519
Height of Dam（ m ）	130	292	132	120	262	107	/	/
Total Reservoir Capacity （ hundred million m3 ）	5.1	151.3	10.6	8.9	237	12.3	/	/
Installed Capacity（ MW ）	750	4200	1500	1350	5850	1500	150	600
Annual Power Generation （ hundred million kWh ）	39.4	188.9	76.0	67.1	239.0	76.2	7.8	28.9

3. Strategic Environmental Assessment (SEA) of Hydropower Planning

The Lancang River hydropower development strictly abides by relevant national administrative procedures



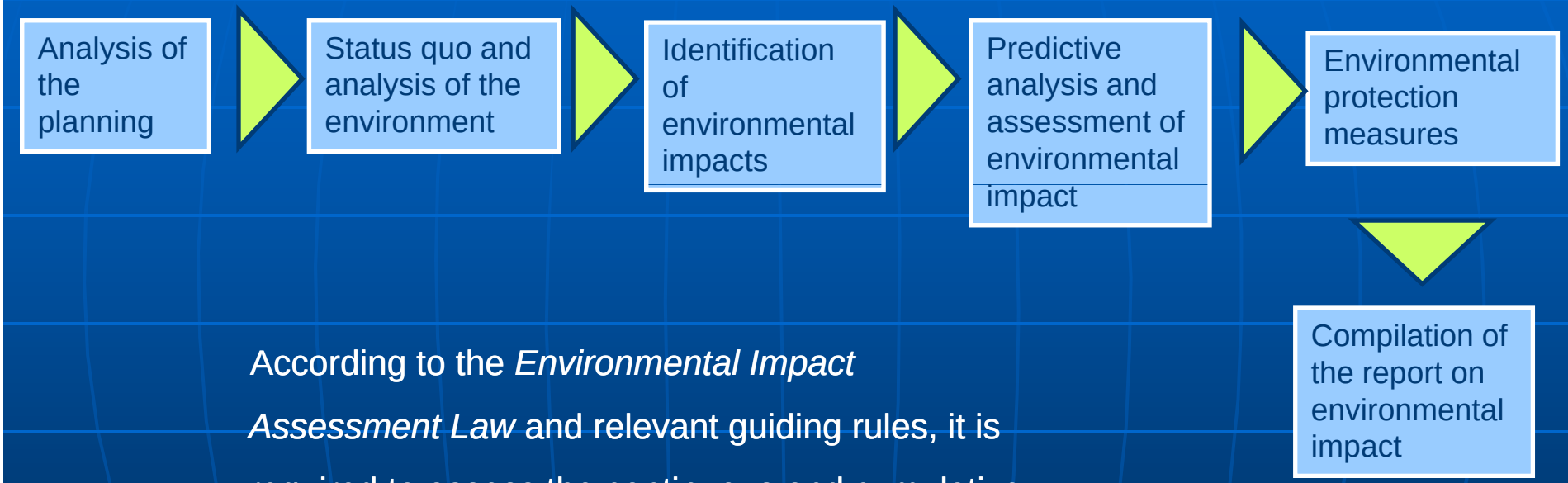
Relevant Laws and Regulations Norms and Standards

Laws and Regulations:
Environmental Protection Law of the People's Republic of China
Environmental Impact Assessment Law of the People's Republic of China
Water Law of the People's Republic of China
Law of the People's Republic of China on Water and Soil Conservation
Regulations of the People's Republic of China on Natural Reserves, etc.

Technical Specifications and Norms:
Guiding Rules for Environmental Impact Assessment: Non-pollution Ecological Impact, HJ/T19-1997
Standard for Environmental Impact Assessment of River Basin Planning, SL45-92
Quality Specifications for Surface Water, GB3838-2002
Technical Guiding Rules of SEA (Trial), etc.

Technical Papers:
Report on the Segment Planning of Midstream and Downstream Lancang River,1986
Study of the Environmental Planning of Lancang River Basin in Yunnan Province, 1992
Regionalization of Water Functions in Yunnan Province, 2005, etc.

Hydropower SEA Process



According to the *Environmental Impact Assessment Law* and relevant guiding rules, it is required to assess the continuous and cumulative impacts of a hydropower station to the river's eco-environment, as the assessment process chart demonstrates.

Contents of Each Process

Analysis of the planning

Description of the planning, analysis of the compatibility of its objectives, preliminary selection of the planning schemes, determination of the SEA contents and evaluation scope, etc.

Status quo and analysis of the environment

The investigation covers environmental, social and economic domains. Its major contents include: current major environmental problems and their causes; analysis of ecologically sensitive points to identify the key environmental factors influenced by the planning; analysis of the environmental limitations for the objectives and schemes of the planning; “Zero Plan” analysis.

Identification of environmental impact

Identify major environmental impact and its nature resulted from the execution of environmentally feasible planning, prepare the environmental impact identification table, and select assessment indicators.

Contents of Each Step

Predictive analysis and assessment of environmental impact

Its major contents include: assess the impact of the planning on the environmental protection objectives and environmental quality; analyze the rationality of the planning. Some commonly applied methods include expert consultation, checklist, matrix, mathematical model, overlay, etc.

Environmental Protection Measures

For each planning scheme, tentatively design its environmental protection measures; identify the recommended planning schemes which are environmentally feasible; and draw up the methods for monitoring and follow-up assessments.

Compilation of the report on environmental impact

It largely covers nine topics: general provisions, overview of the planning draft, description of the environment status quo, analysis and assessment of environmental impact, environmental protection measures, public engagement, monitoring and follow-up assessment, difficulties and uncertainties, and executive summary.

Evaluating Indicator System of Environmental Impacts of Hydropower Program

The evaluating indicator of environmental impacts of hydropower program mainly describes and identifies the environmental background situation and overall trend of environmental changes, and masters the environmental effect degree possibly resulted from the program implementation from macroscopic perspective, which shall be deemed as the important basis for establishing environmental protection objective and optimizing the program.

Due to the integrity, potentiality and accumulation of environmental influence of river hydropower cascades, it is very necessary to rationally establish the evaluation indicator system.

Through studying the environmental influence of river hydropower cascade program of Lancang River, Dadu River, Nujiang River, Yalong River, etc., we may conclude the research and evaluation indicator system of environmental influence of river hydropower program. See the following tables.

Evaluating Indicator System of Environmental Influence of Hydropower Program

System	Environmental protection objective	Environmental elements	Environmental factors
Water environment	Rationally develop and utilize water resources, protect the water quality of river basin, rationally dispatch to reduce the influence of releasing of water with low temperature, and protect the water in functional zones and functional nature of water environment	Hydrology	Flow rate, run-off, water level, flow speed and evaporation
		Sediment	Sediment runoff, sediment concentration and deep erosion
		Water resources	Water resources quantity, water consumption and development and utilization amount
		Water temperature	Water temperature in reservoir areas and outflow temperature
		Water quality	Water environmental function, pollutant source, organic pollutant and dissolved oxygen (DO)
		Substrate	Heavy metal
Ecological environment	Protect and improve the ecosystem structure and functions of river valley, maintain the ecological integrity, protect natural reserve, precious and rare animals and plants and ecological environment and reduce water loss and soil erosion	Ecological integrity of river basin	Production capacity and stability of natural system
		Terrestrial plant	Plantage, plant resources and precious threatened plants
		Terrestrial animal	Terrestrial animal resources
		Natural reserve	Natural reserves at the national and provincial Cascades
		Aquatic organism	Aquatic organism component, fish resources and other aquatic organisms
		Water loss and soil erosion	Type and level of water loss and soil erosion
Social environment	Utilize hydropower resources, promote regional and social development, improve the quality of life, and protect natural landscape and cultural relics	Economic development	Macro-economy, development of industry and agriculture and tertiary industry and regional economy
		Social development	Urbanization progress, and quality of life and population
		Population health	Sanitary environment and environmental disease

Evaluating Indicator System of Environmental Influence of Hydropower Program – Water Environment

Environmental elements	Environmental factors	Evaluating indicator	Environmental elements	Environmental factors	Evaluating Indicator
	Flow rate	Monthly average flow	Water resources	Water resources quantity	Total annual water resources quantity
		Average runoff of low water month		Water consumption	Water amount for industry and agriculture and life
	Runoff	Typical annual flow		Development and utilization amount	Annual development and utilization amount
		Runoff in flood and drought periods	Water temperature	Water temperature in reservoir areas	Accumulated monthly average water temperature of cascade hydropower station
	Water level	Normal impounded level		Outflow temperature	Accumulated monthly average outflow temperature of cascade hydropower station
		Water level in flood period	Water quality	Water environmental function	Categories of water quality in functional areas
	Flow speed	Dam flow speed		Pollutant source	Waste water discharge amount and total discharge amount of pollutants
		Flow speed of reservoirs		Organic pollutant	BOD5
	Evaporation	Multi-year average evaporation capacity		Dissolved oxygen (DO)	DO
	Sediment runoff	Annual and monthly sediment runoff	Substrate	Heavy metal	Plumbum, chromium, etc.
	Sediment concentration	Annual and monthly sediment concentration			Adsorption rate of sediments
	Deep erosion	Annual average deep erosion			

Evaluating Indicator System of Environmental Influence of Hydropower Program - Ecological Environment

Environmental elements	Environmental factors	Evaluation indicator
Ecological integrity of rivers basin	Production capacity of natural system	Evaluation of biomass
	Stability of natural system	Restoration and resistance of stability, advantage degree value of landscape pieces, stability of landscape layout and ecosystem lowers than the continuity
Terrestrial plant	Plantage	Plant family, genus number of types
	Plant resources	Plant types, submersed species area, and damaged floor space
	Precious threatened and protected plants	Level and submerged and occupied number of Precious threatened and protected plants
Terrestrial animal	Terrestrial animal resources	Animal types, species group and number and species group and number of precious threatened and protected animals
Natural reserve	Natural reserves at the national and provincial Cascades	Types of conservation zones, protected objects, function division and project distance, and influenced areas
Aquatic organism	Plantage of aquatic organism component	Order, family and species of plantage
	Fish resources	Types and number of main economical fishes
	Other aquatic organisms and precious special fishes	Endangered degree, protection level, species and number
Water loss and soil erosion	Type of water loss and soil erosion	Types and areas of soil corrosion
	Degree of water loss and soil erosion	Mode number of soil corrosion

Evaluating Indicator System of Environmental Influence of Hydropower Program – Social Environment

Environmental elements	Environmental factors	Evaluating Indicator
Economic development	Macro-economy	Energy production and consumption
	Development of industry and agriculture and tertiary industry and regional economy	Output value of industry, agriculture and tertiary industry
	Regional economy	Optimization degree of industrial structure, coordination of urban and rural economies and industrial and fiscal revenue
Social development	Urbanization progress	Level of urban development and rural urbanization
	Quality of life	Environment quality and quality of life for human settlement
	Quality of population	Educational level and degree of science education
Population health	Sanitary environment	Sanitation of drinking water
	Environmental diseases	Disease incidence and prevalence of natural focus diseases, water-borne communicable diseases, etc.

From the research results and evaluating examples, we may see that the influence of river step power station upon hydrology, water temperature and types of aquatic organisms is comparatively obvious.

4. Study of the eco-environmental impact of Lancang River hydropower development

China has paid adequate attention to the issue that hydroelectric development of Lancang River exits great influence upon eco-environment and downstream countries, and repeatedly research and demonstrate the said issue from different Cascades and perspectives, which reflect the conscientious attitude and full respect to the downstream countries. Since 2002, the following tasks have been entrusted by the relevant departments and units under the Chinese government:

(1) China Hydropower Engineering Consulting Group and China Institute of Water Resources and Hydropower Researc h (IWHR) co-conducted the analyzing and evaluating work of the influence of the development of Lancang River upo n eco-environment and regions of \lower reaches of Lancang River.

(2) Asian International Rivers Center of Yunnan University conducted the research work of cross-border influence and co untermeasures of cascade development of Lancang River

(3) Canada Dilong Environmental Science Consultation Company conducted the monographic study on the influence of hydroelectric development of Lancang River upon downstream regions.

4.1 Organization

- Leading units:

General Institute of Hydropower & Water Resources Planning and Design

General responsible

- Participants:

Yunnan Huaneng Lancang River Hydropower Co., LTD.

Organization and coordination

China Institute of Water Resources and Hydropower Research (IWHR)

Monographic study on water environment

Kunming Institute of Zoology of the Chinese Academy of Sciences and School of life Sciences of Yunnan University

Monographic study on aquatic ecosystem

Yunnan Institute of Environmental Science (YIES) and Yunnan Environmental Information Center

Monographic study on terrestrial ecology

Research Centre for Sustainable Development of Chinese Academy of Social Sciences Monographic study on economic society

Asian International Rivers Center of Yunnan University

Study on ecological and environmental information management system

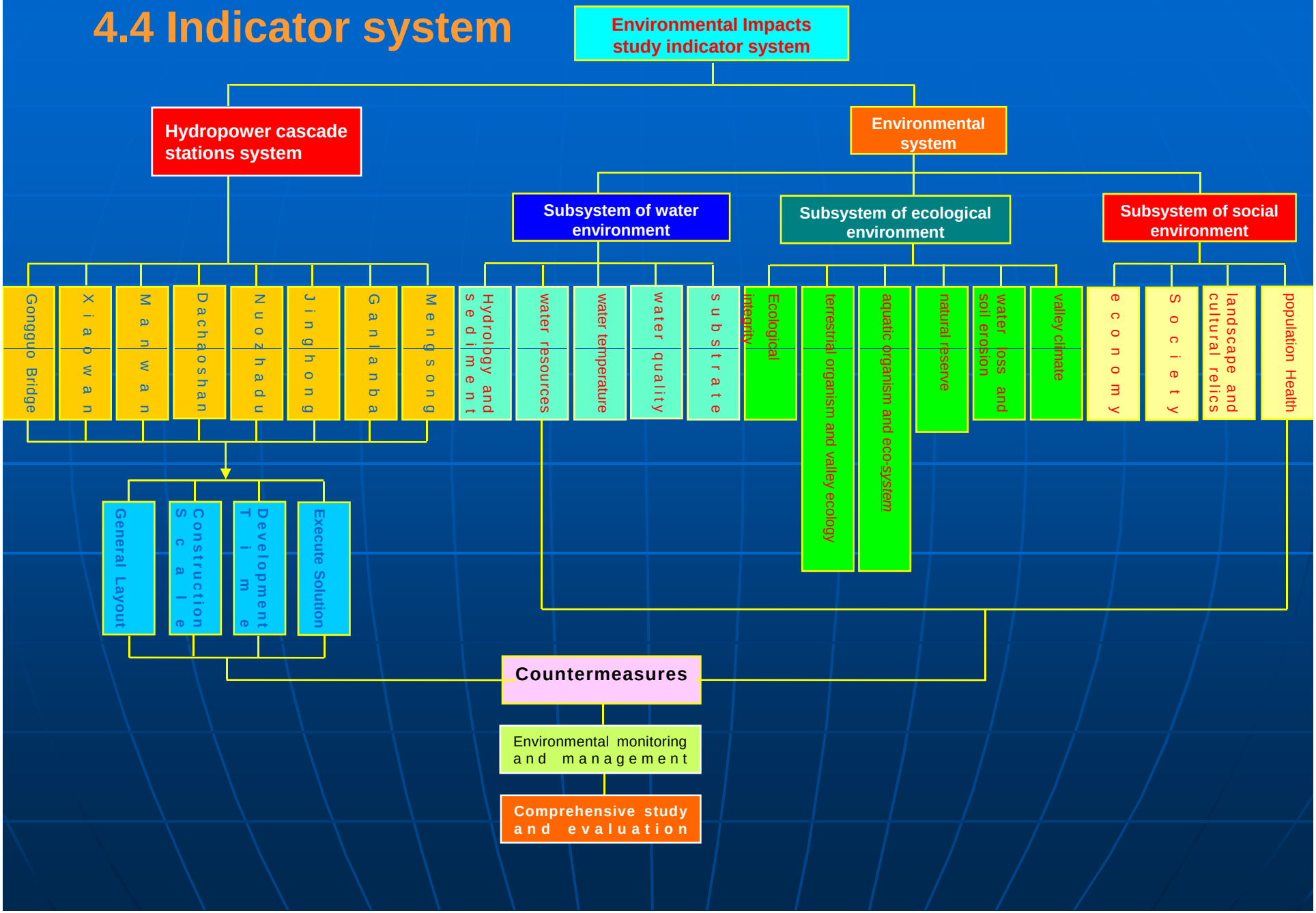
Hydrochina Kunming Engineering Corporation

Overview of step hydropower station and environmental basic research

4.3 Research Work Process

- Complete *Research and Evaluation Work Outline of Environmental Influence of Cascade hydropower stations at the midstream and downstream of Lancang River* at the end of 2002
- In January 2003, the Ministry of Environment Protection presided over the outline review meeting;
- In October 2003, the on-site comprehensive survey was made.
- In October 2004, 6 specific research results were put forward; from November to December 2004, 4 main specific research were reviewed.
- In December 2005, the *Research and Evaluation Report of Environmental Influence of Cascade hydropower stations at the midstream and downstream of Lancang River* was completed.
- In November 2005, the Ministry of Environment Protection reviewed and accepted the *above report.*

4.4 Indicator system



4.5 Main Research Achievements

- ## General report

Research and Evaluation Report of Environmental Influence of step hydropower station at the midstream and downstream of Lancang River

- ## Specific research report:

Special subject 1 - *Research and Evaluation Report of Step Hydropower Station Construction at the Midstream and Downstream of Lancang River upon Water Environment*

Special subject 2 - Research and Evaluation Report of Step Hydropower Station Construction at the Midstream and Downstream of Lancang River upon Aquatic Organisms

Special subject 3 - Research and Evaluation Report of Step Hydropower Station Construction at the Midstream and Downstream of Lancang River upon Terrestrial Ecology

Special subject 4 - Research and Evaluation Report of Step Hydropower Station Construction at the Midstream and Downstream of Lancang River upon Social Economy

Special subject 5 - Research Report on Ecological and Environmental Information Management Sys tem of Step Hydropower Station at the Midstream and Downstream of Lancang River

Special subject 6 - Overview of Step Hydropower Station at the Midstream and Downstream of Lan cang River and Basic Research on Natural and Social Environment

preliminary study on the influence of hydroelectric development of Lancang River upon downstream overseas environment, etc.

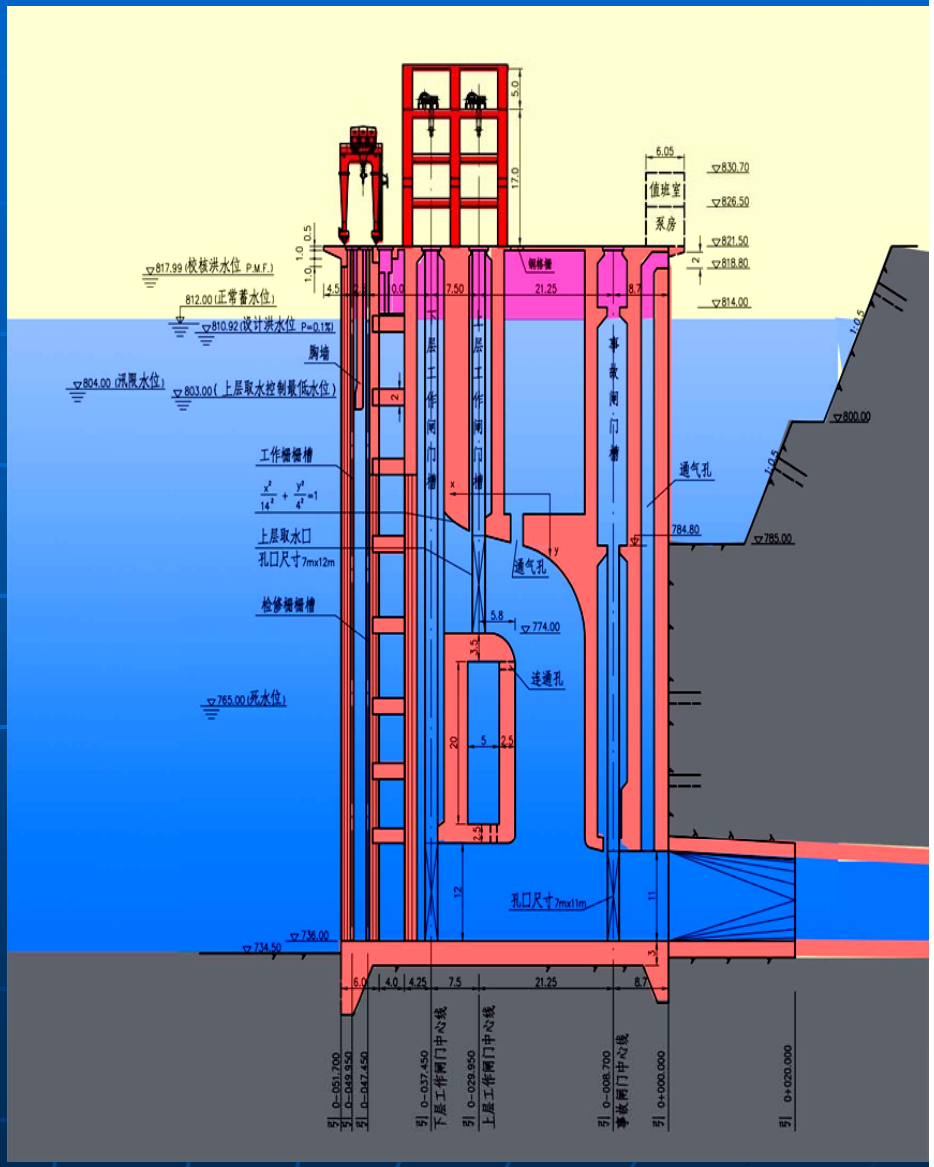
4.6 Main Research Conclusions

1. Hydroelectric development of Lancang River will exert no influence upon the total quantity of water in downstream areas;
2. Hydroelectric development of Lancang River will exert certain influence upon the sediment in Mekong River;
3. Hydroelectric development of Lancang River will exert no separation influence upon migratory fishes;
4. Hydroelectric development of Lancang River will make benefit to flood control, irrigation and water supply in the downstream areas.
5. The storage capacity of the current completed Manwan Hydropower Station, Dachaoshan Hydropower Plant and Jinghong Hydropower Station is very small and exerts little influence upon the downstream areas; the role of regulation and storage of the completed Xiaowan Hydropower Plant and Nuozhadu Hydropower Plant can reduce the water quantity in flood period and increase the water quantity in drought period; however, the water quantity of Lancang River only accounts for 13.5% of discharge flow into sea of Mekong River. As the water quantity of downstream reaches continue to increase, the influence become little.

4.7 Main Counter-measures Adopted by Hydroelectric Development of Lancang River

- 1. In order to reduce the influence of low temperature water, Nuozhadu Hydropower Plant adopts stratified water intake measure;
- 2. According to the ecological requirements of downstream reaches, the cascade stations release ecological base flow;
- 3. For mitigating the flow fluctuation of the Lancang River at the boundary, it is necessary to build Ganlanba station and operate it in a special mode.
- 4. In order to reduce the influence to 4 kinds of migratory fishes, Mengsong cascade at the lowest reaches shall be postponed to build;
- 5. Plan to build fish artificial fecundation and release measures;
- 6. Further research on joint-operation style of hydropower cascades stations, taking full consideration of eco-system requirement. etc.

Stratified Water Intake Engineering Measure of Nuozhadu Hydropower Plant



Xiaowan and Nuozhadu Hydropower Plants belong to the type of water temperature stratified. And the stratified water intake measure is applied in these two projects, which can reduce the adverse effect of low temperature water upon the downstream reaches.

Influence upon Migratory Fishes and Measures

Lancang River has a total of 153 fishes, while the fishes in Mekong River reach 1,200;

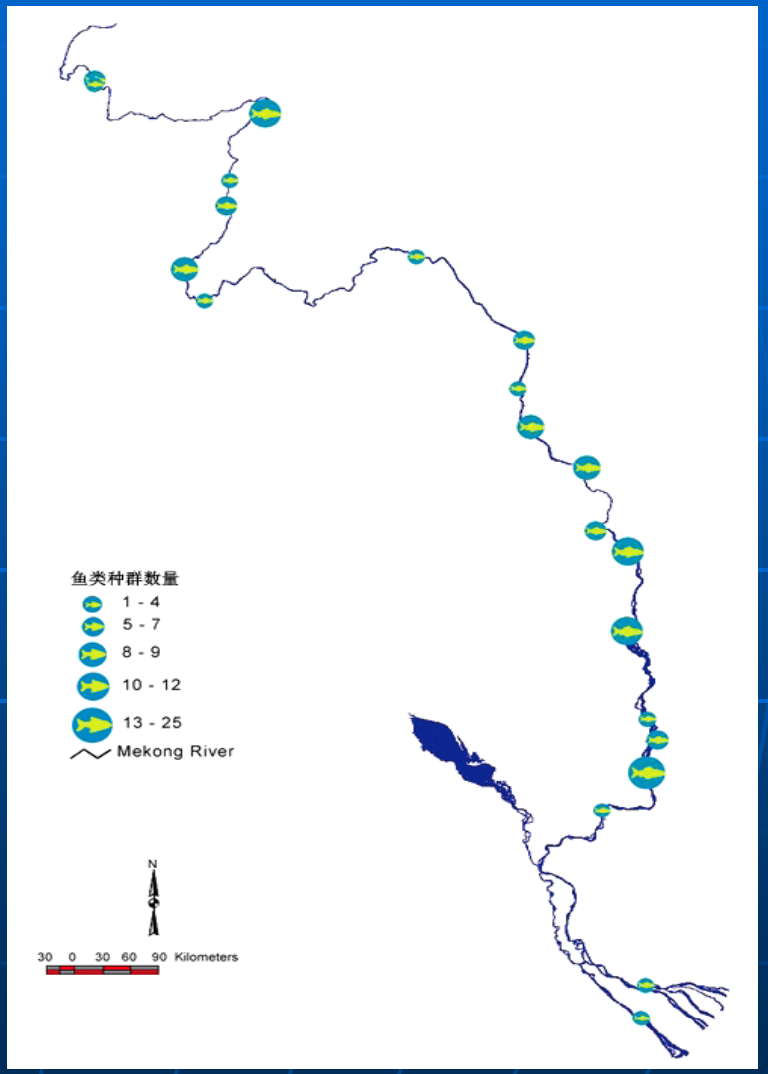
Four migratory fishes need to migrate to spawn from Mekong River to Buyuan River in Xishuang Banna, China in the spawning season over long distance. However, in the main stream of Lancang River, the trace of the said migratory fishes has not been found above the Jinghong reach.

Pangasius sanitwangsei (Smith)

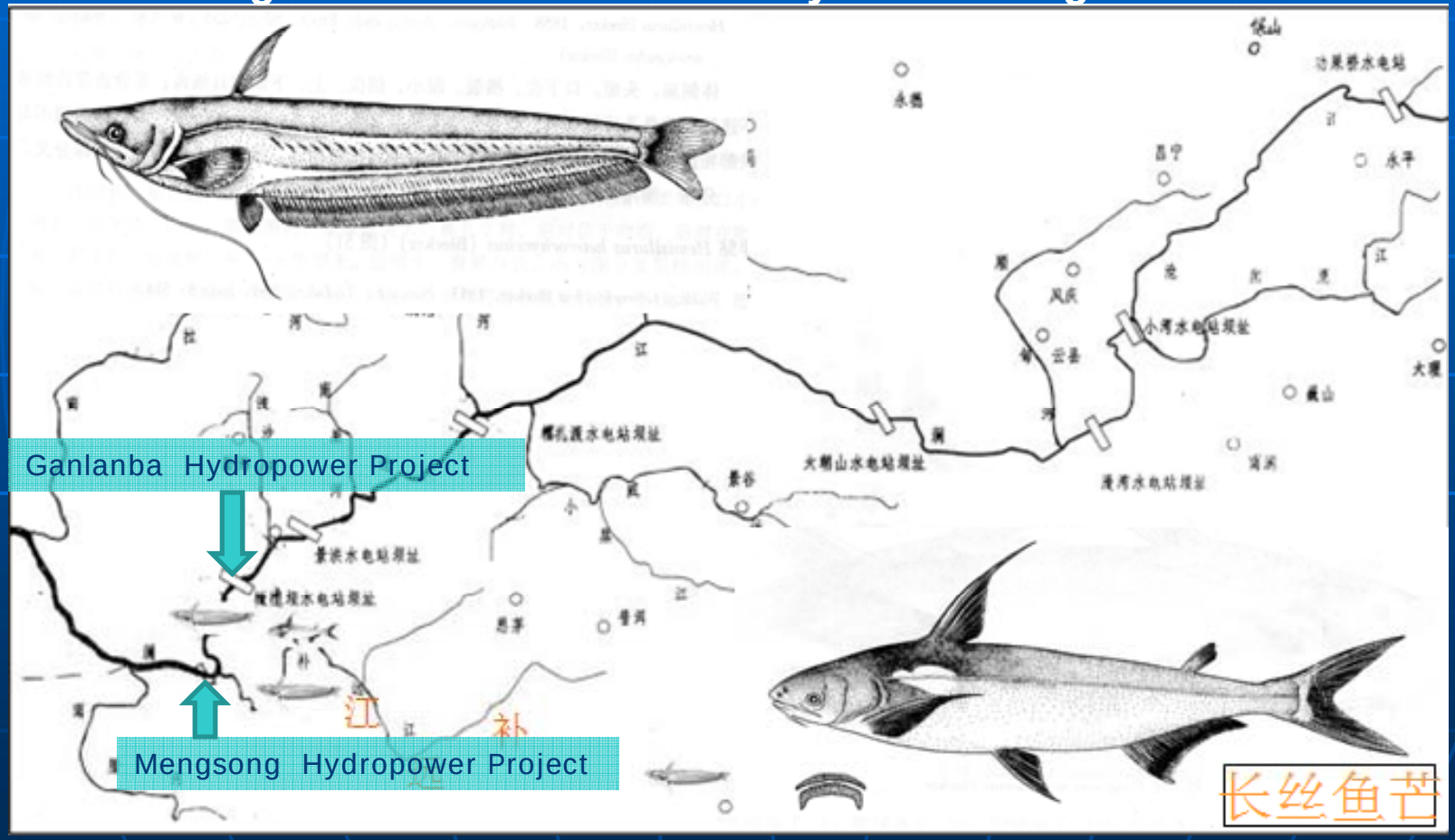
Pangasius nasutus(Bleeker)

Pangasius micronemus(Bleeker)

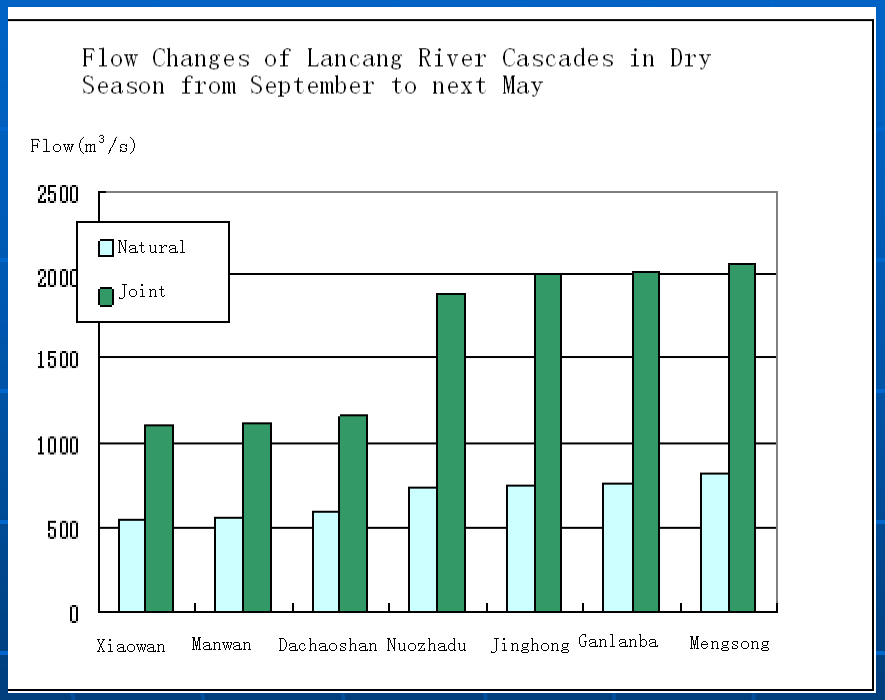
Pangasius beani(Smith)

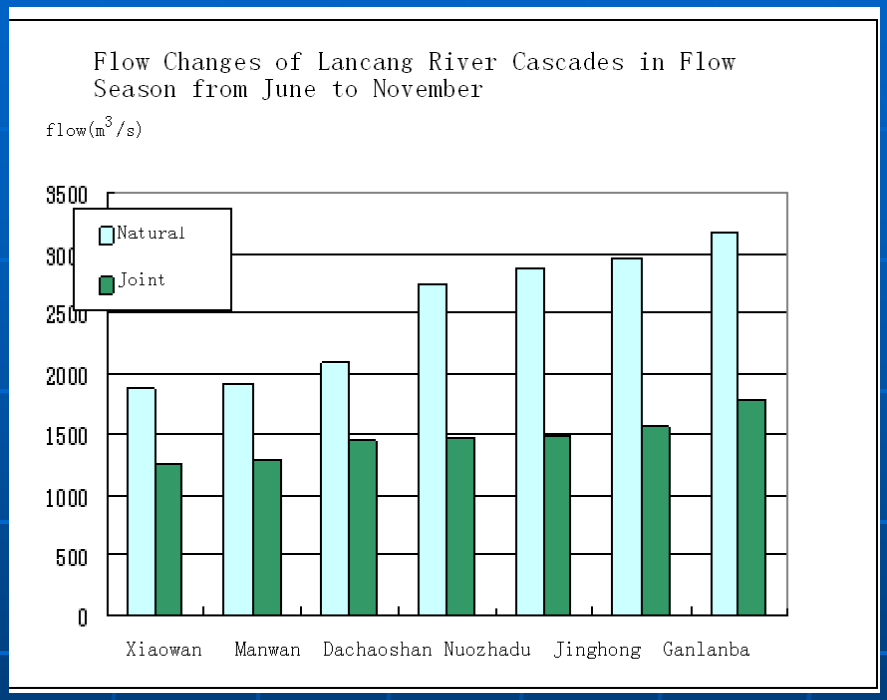


In order to maintain the passage to Buyuan River for migratory fishes, Mengsong Hydropower Station shall be postponed, although the local government and community have strong desire to build it.



Influence of Reservoir Regulation on Downstream





1) In the dry season, the runoff from cascade stations is larger than that of natural status, and the projected average flow from December through next May is 1.35 times more than that of nature status.

2) In the wet season, the said runoff is smaller than that of natural status, and the projected average flow from June through November is 60% of that of natural status.

Influence of Reservoir Regulation on Navigation of Downstream

Currently, China, Laos, Myanmar, Thailand have signed the *Agreement on Commercial Navigation on the Lancang-Mekong River*. However, because the natural stream is shallow and the dry season exerts a relatively large influence on navigation, it's only allowed for the seasonal passage of small-size ships with load below 300t. Upon the completion of Xiaowan Hydropower Station, the average flow during the dry season will be significantly boosted, which is favorable for the navigation development of Lancang-Mekong River.

The regulation operation of Nuozhadu Reservoir (with active storage of 12. 195 billion m^3) and Ganlanba Reservoir has further improved the navigation conditions of Mekong River.

Influence of Reservoir Flood Regulation on Downstream Mekong River

Such two large-scale reservoirs as Xiaowan and Nuozhadu will reduce the downstream flood peak and volume. As the said peak and volume of lower reaches constantly increase, their role of flood control will be limited.

The annual runoff of Lancang River is about 13.5% of that of Mekong River mouth, and the rainfall of Mekong River Basin is larger than that of Lancang River, therefore, flood regulation in Lancang River may exert little influence on the downstream Mekong River.

Influence on Sediment of Downstream

According to the monitoring, the sediment of Mekong River mainly originates from northern Laos. Based upon relevant data analyses, among its10 sub-basins with the highest sediment yield, 9 locate within Laotian territory and 6 in northern Laos, which is consistent with the rainfall distribution in the basin of Mekong River.

Along with the construction of hydropower stations, and with water and soil conservancy , the sediment discharged downstream in Lancang River is tend to decline distinctly, which could help reduce the sedimentation, facilitate irrigation and navigation of the Mekong river course. This is an important contribution for the lower Mekong River.

5. Impounding scheme and guarantee measures of Xiaowan Reservoir

Principles:

(1) The letdown flow during initial impounding period shall satisfy the integrated water demand of agriculture, navigation, ecosystem along the downstream Lancang-Mekong River.

(2) According to the downstream water requirement, make sound impounding scheme for Xiaowan Reservoir.

Important factors of impounding scheme:

（1）Irrigation and water supply requirement in Mekong River Basin
（2）downstream ecological requirement
（3）downstream Navigation requirement
（4）Flood control requirement

Plan:

Xiaowan Reservoir is supposed to store water during the flood season and be mainly responsible for retaining flood. In addition to minimizing the state flood prevention pressure, try to maintain the normal letdown flow during non-flood season so as to reduce the influence of water conservancy on the lower reaches.

■Guarantee Measures

1 ）Staged water conservancy

The normal pool level of Xiaowan Reservoir is 1240m, and staged method is adopted in early period:

a) The water conservancy during the 2009 major flood season reaches the dead water level of 1166m;

b) During the 2010 flood season, the impounded level varies between 1166m and 1240m.

2 ）Water conservancy measures

Carry out reservoir impoundment in strict accordance with the fixed flow, try to preserve the natural flow process of river channel in the preliminary impoundment process.

3 ）Re-regulating reservoir

During the water conservancy process of Xiaowan Reservoir, if the letdown flow precipitously fluctuates, conduct joint operation and regulation through such downstream reservoirs as Manwan, Dachaoshan, and Jinghong in particular, re-regulate the letdown flow of Xiaowan Reservoir so that the departure flow can meet the integrated water requirement of downstream Mekong River.

Future Tasks

1) Vigorously implement the requirements on staged impounding of Xiaowan Reservoir, and conduct stringent inspection in phases.

2) With the help of MRC and other downstream countries, further carry out the next-stage impounding research work to avoid negative impacts and obtain more positive ones on the lower reaches.

3) Pay constant attention to the operation mode of the completed hydropower stations and their influence on the low reaches. Where necessary, adjust the said mode of cascade stations on the basis of intensive study.

6. Contribution of Hydropower Construction to the Development of Local Economy

In November 2007, entrusted by NDRC, General Institute of Hydropower and Water Resources Planning and D esign organized 8 research institutions, conducted specific research on the contribution of Middle-lower Lancang River hydropower development to the local economy development.

6.1 Task, organization and subject of research project

- Major tasks

1) Learn about the socio-economic development conditions of the reservoir areas of the hydropower stations completed or still under construction, objectively evaluated the influence of hydroelectric construction on the socio-economic development of the said areas. Summarize and analyze the current policies concerned of hydroelectric construction and their functions.

2) In light of the principle of boosting local socio-economic development, conduct in-depth research on and propose the operation and management system of station construction as well as the fiscal and tax policies better promoting local socio-economic development.

Hydropower stations selected:

Three built hydropower stations were selected in Middle-lower Lancang River.

Xiaowan Hydropower Station ,

Dachaoshan Hydropower Station,

Manwan Hydropower Station.

6.2 Conclusions:

➢ Contribution to local socio-economic development

1) Satisfy power demands, optimize energy structure, boost China's economic development, replace fossil energy, promote environment protection; boast comprehensive utilization efficiency, i.e. flood control, water supply, irrigation, navigation, etc.; spur the development of our national industries

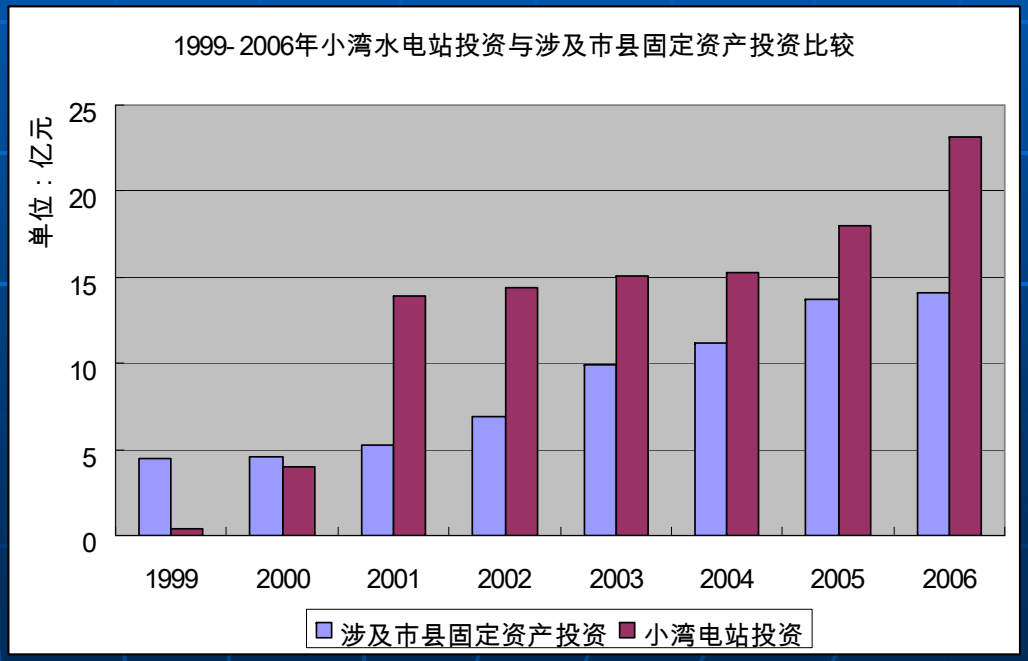
2) Increase fixed asset investment in local areas; stimulate local GDP growth; enhance local tax revenue

3) Improve local public infrastructure; optimize the fuel structure of residents, promote ecological environment protection; give full play to the comprehensive functions of reservoirs, i.e. flood prevention, water supply, irrigation, navigation, aquaculture, tourism development, etc., enhance the sustainable development of local society and economy; boost the adjustment of local industrial structure

➢ Case 1 Xiwan Hydropower Station Promotes Local Investment

The installed capacity and annual power generation of Xiaowan Hydropower Station are 4200MW, 18.99 billion kWh, respectively, with a total construction period of 11 years. Its construction started in February 2001, and the first generating unit will be put into operation at the end of 2009 and all construction will be completed in 2011.

From the figure, we can see that as the investment in Xiaowan Hydropower Station increases annually, the fixed asset investment in its surrounding cities and counties has been on a high level for several years, but the overall tendency is basically the same, which indicates that the said station is closely related to and has a significant impact upon the local fixed asset investment.



➢ Case 2 Comprehensive Efficiency of Xiaowan Hydropower Station

As the leading station of hydropower cascade development in the middle and lower reaches of Lancang River, Xiaowan Hydropower Station boasts a total reservoir capacity of 14.914 billion m^3, installed capacity of 4.2 million kW(6x700 thousand kW) and annual energy production of 18.99 billion kWh, with regulation capability for many years.

1) Tourism The reservoir backwater is as long as 178 km, with an artificial lake of about 189.1km^2，creating favorable conditions for the development of tourism resources.

2) navigation The reservoir regulation of Xiaowan Hydropower Station (including that of the downstream Nuozhadu Reservoir) will increase the natural flow of Ganlanba (Simao Port) in dry season from ca. 400m^3/s to ca.1400m^3/s, markedly improve the downstream navigation conditions, turning the seasonal navigation in the lower reaches to be available for all the year round.

3) Cascade Compensation Xiaowan Hydropower Station will yield great compensation benefits to the hydropower station group of Yunnan Province, and the firm capacity of the said group shall increase by 2970.6MW (ca.2.12 times)

6.3 Counter measures

In order to uphold the people-oriented Scientific Outlook of Development, promote the sustainable development of hydroelectric power, the following countermeasures are also put forward:

1) Transfer natural resource advantages to economic advantages;

2) Establish and perfect the resource property system;

3) Improve resource compensation mechanism;

4) Conduct researches on the long-term benefit-sharing system of water resource development, the benefit compensation and sharing system of flood prevention, water supply, irrigation and shipment.

Thank you