The Role of Cascade Reservoirs on the Lancang River for Flood Control and Drought Relief of the Mekong River

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Outlines

1. Introduction on Development of the Lancang River

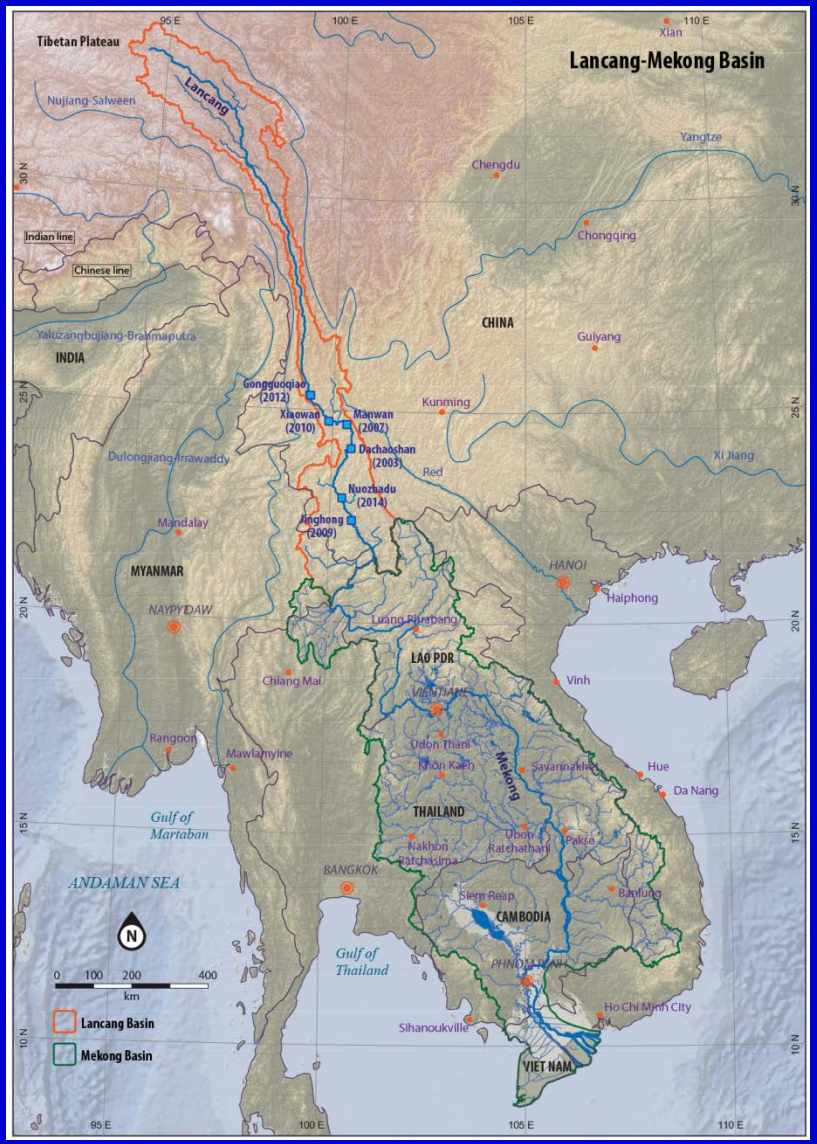
2. Impacts of Climate Change on Lancang-Mekong River Basin

3. Preliminary Analysis on Performance of Cascade Reservoirs on Flood Control and Drought Relief

Characteristics of Lancang-Mekong River

The Lancang-Mekong river originates in the Qinghai-Tibetan Plateau of China, and flows southeastward through Myanmar, Laos, Thailand, Cambodia, and Vietnam.

	Basin	China	% of China
Drainage Area (10^4 km^2)	81.24	16.44	20.2
Length of Mainstream (km)	4880	2161	44.3
Average Annual Runoff (billion m^3)	475	64	13.5



Development of Lancang River

The main missions of development of the Lancang River are:

(1) rationally exploiting hydropower resources,

(2) securing water supply for drinking, agriculture, and industry,

(3) preventing again flood ,

(4) effectively protecting aquatic ecosystem and environment.

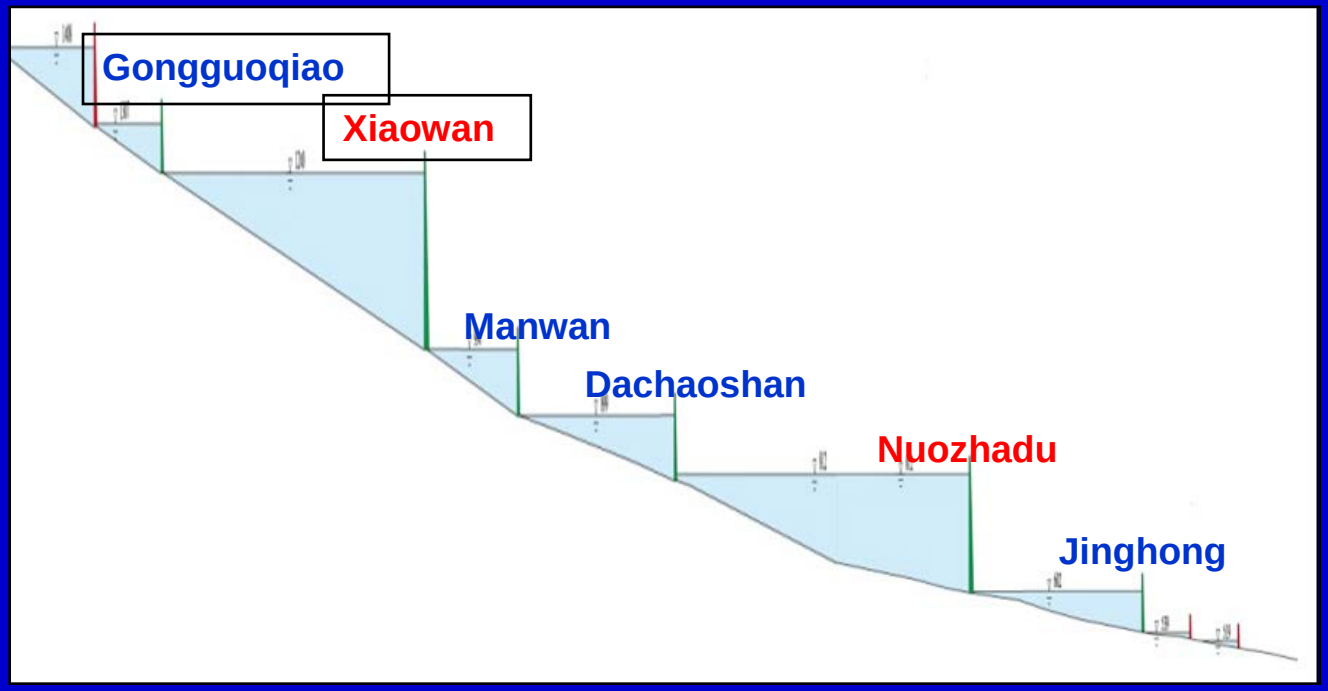
Up to now, 6 hydropower stations has been built on the middle and lower reaches along Lancang River named

Gongguoqiao, Xiaowan, Manwan, Dachaoshan, Nuozhadu, Jinghong

Development of Lancang River

References of cascade hydropower sations built on middle and lower reaches along Lancang River

Name of Station	Gongguoqiao	Xioawan	Manwan	Dachaoshan	Nuozhadu	Jinghong	Total
Normal Water Level (m)	1307	1240	994	899	812	602	
Regulating Storage Capacity ($10^8 m^3$)	0.49	98.95	1.23	2.75	113.35	3.09	219.86



Development of Lancang River

Xiaowan hydropower Station

Development of Lancang River

Nuozhadu hydropower Station

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Impacts of Climate Change on Lancang-Mekong

Tsinghua University in China has carried out the studies of the impacts of future climate change on the hydrological regime of Lancang-Mekong River Basin, the main conclusions and comments are cited as following:

(1) In 2100, the average temperature will increase while precipitation decrease. According to the 3 scenarios for Carbon Dioxide emmissions in the future given by IPCC, the climate change is listed as following:

Climate Change in 2100

Scenarios	rcp4.5	rcp6	rcp8.5
Changes in T	+0.01	+0.08	+2.2
Changes in P	-155	-213	-196

Note: Source from the research results of Tsinghua University in Beijing

Impacts of Climate Change on Lancang-Mekong

(2) The annual runoff will decrease due to precipitation decreasing;

(3) Climate change will increase inter-annual difference in runoff which means extreme hydrological event will become more frequent;

(4) The intra-annual variation of runoff in the upper and middle reaches of the Lancang-Mekong River will be more significant.

The simulation calculatoin of Chiang Saen hydrological station shows that: the runoff in flood season and in dry season will respectively increase and decrease. The distribution of water resources during the year is even more uneven.

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Preliminary Analysis on Performance

- The cascade reservoirs built on the middle and lower reaches of the Lancang River have a large regulating capacity, especially Xiaowan and Nuozhadu with a total regulating capacity of about 22billion m^3. The cascade reservoirs play a positive role on flood control and drought relief, power generation and navigation for the Mekong River, by scientific regulation of retaining and storing floodwater in flood season and increasing discharges in dry season.

Preliminary Analysis on Performance

Analysis Methodology:

➢**Long-term average:** **Selecting long series of hydrological data(1967-2013) measured on the mainstream of the Lancang River, calculating the discharges from Jinghong Reservoir ,comparing with the discharges under natural condition(no dam conditions), analyzing the effect of cascade reservoirs on flood control and drought relief .**

➢**Case study:** **Flood in 1966**

Drought in 2010

Emergency water supplement in 2016

Performance on Flood Control

Long-term average:

- In wet season, scientific operation on cascade reservoirs could retain and store flood, and decrease the water level in the downstream, which can effectively relieve the flood control pressure of the mainstream in the upper and Middle reach of the Mekong River.
- The long-term average flow of the Lancang River out of China could be reduced by 30 % during the wet season compared with that under the natural conditions.
- The long-term average discharge of the Lancang River out of China could be reduced by 1300m^3/s during July to August.
- The water level at Chiang Saen and Vientiane could be reduced respectively about 1 m and 0.8m on average during wet season.

Performance on Flood Control

Case Study : Flood in 1966

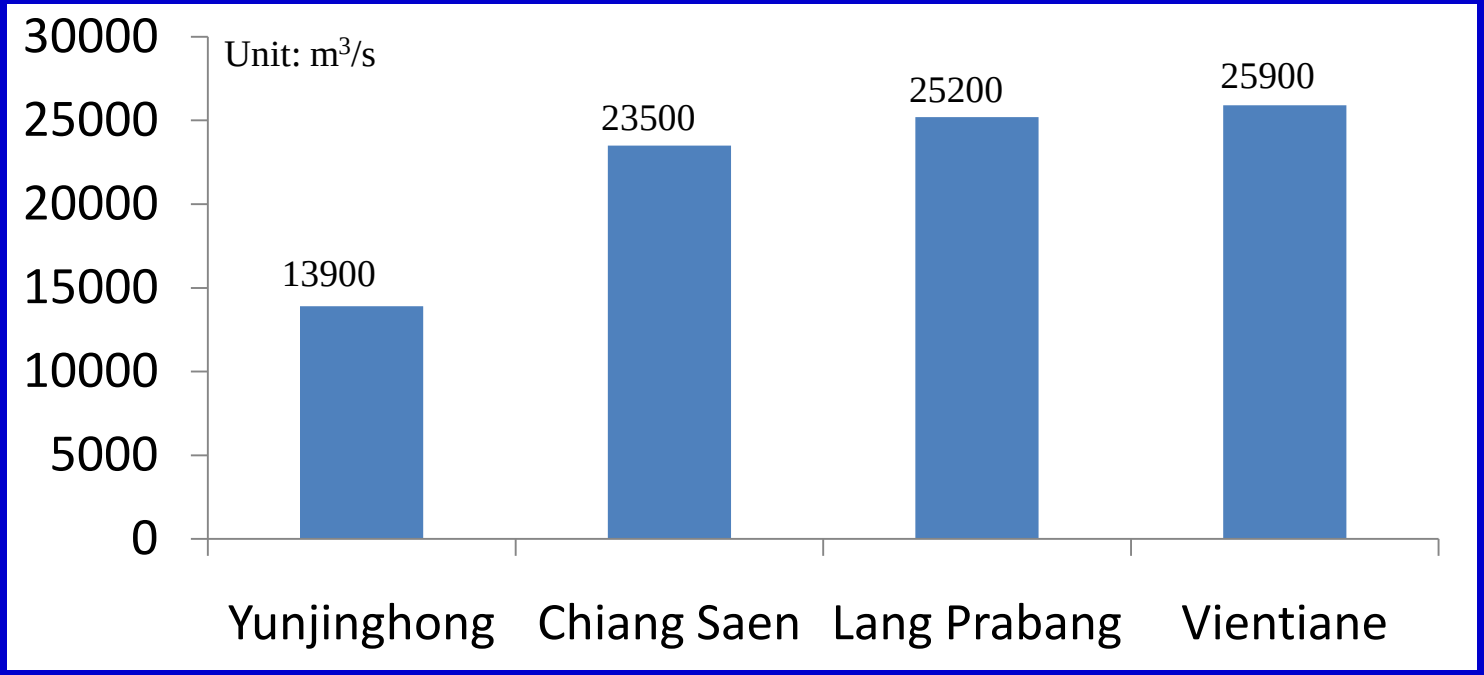
- The flood during Aug. to Sep. in 1966 was the most serious basin-wide flood since observation data has been recorded, with recurrence interval of 50 years, causing serious damage to the reparian countries.

- During 30 days of the flood process , the total volume of discharge at Yunjinghong station was 22 billion m^3, the discharge concluded from observation data was 13900m^3/s, ranking the first place since 1953.

Performance on Flood Control

Case Study : Flood in 1966

During the flood process, the maximum water level observed at Chiang Saen station was 13.80m, ranking the first place since 1961.



Peak flow observed

Performance on Flood Control

Case Study : Flood in 1966

- Under the current condition, through scientific operation and regulation the cascade reservoirs on Lancang River can play a significant role on flood in Mekong River.

- Simulation results showed: in case of extraordinary flood with recurrence interval of 50 years, with the type of 1966, the peak flow and water level at Chiang Sean station could be decreased by 3300 m^3/s and 1.2 m respectively through scientific operation on cascade reservoirs on Lancang River.

Performance on Drought Relief

The Mekong River Basin is prone to drought because of its uneven temporal and spatial distribution of precipitation. Influenced by global climate change, the drought will be much more frequent.

In dry season, scientific operation cascade reservoirs on Lancang River could raise water level through increasing discharge, which will benefit water supply, irrigation and navigation to Mekong River.

Long-term average:

- **The long-term average flow of the Lancang River out of China could be increased by 70 % during the dry season compared with that under the natural conditions(no dam conditions).**

- **The water level from Chiang Saen to Vientiane could be raised about 1 m on average during January to April.**

Case Study 1: Drought in 2010

The Lancang-Mekong River basin suffered a severe drought during the spring season in 2010, affecting seriously the irrigation, fishery, navigation and livelihood of riparian residents, which is still impressive for all the participants.

How about the drought situation in 2013 ?

Case Study 1: Drought in 2010

Runoff and Discharges at Jinghong Hydrological Station

Period	Volume of runoff ($10^8 m^3$)	Average flow (m^3/s)
2012.11～2013.4	74.2	474
2009.11～2010.4	92.9	594
Long term average during the same period	129.5	827

This table show that there was an even more severe drought in the Lancang-Mekong River in 2013

Case Study 1: Drought in 2010

Minimum Water Level Comparison

Year / Station	2010 (m)	2013 (m)	Difference in water level (m)
Chiang Saen	0.96	1.39	0.43
Lang Prabang	2.47	3.01	0.54
Vientiane	-0.18	0.19	0.37

This table showed in 2013 the minimum water level in Chiang Saen, Lang Prabang, and Vientiane were higher than 2010.

Case Study 1: Drought in 2010

In 2013,the Mekong riparian countries had not suffered the same drought like 2010.

Why?

Case Study 1: Drought in 2010

During the dry season in 2013, the cascade reservoirs on Lancany River increased discharge volume about 7 billion m^3, adding 65% of the natural runoff (While in 2010, the upstream cascade reservoirs have not been constructed yet) . That's why the reparian residents felt less obvious of the severer drought in 2013 compared with the situation in 2010.

Case Study 2: Emergency Water Supplement in 2016

Emegency Water Supplement

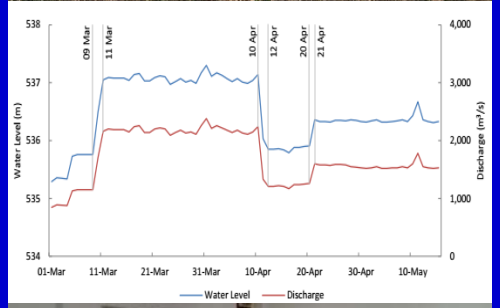
Affected by super EI Nino, Lancang-Mekong River Basin has suffered drought diseater since the end of 2015. The drought condition over Mekong Basin have worsened and triggered China to implement its emengency water supplement by increasing water discharge from Ynnan's Jinghong Reservoir on the request of downsteam countries.

'Three-Phase plan'

- 2016.3.15~4.10: no less than 2000m^3/s;
- 2016.4.11~4.20: no less than 1200m^3/s;
- 2016.4.21~5.31: no less than 1500m^3/s.

Joint Observation and Evaluation

MWR of China and MRC Secretariat co-organised experts from both sides to coduct a Joint Observation and Evaluation of the Emergency Water Supplement from China and its effect of easing the drought situation in the Mekong Basin.



Case Study 2: Emergency Water Supplement in 2016

Positive Effect: the emergency water supplement from cascade reservoirs increased water level and discharge along the Mekong mainstream and decreased salinity intrusion in the Mekong delta.

- **Total volume released from cascade reservoirs: 12.65 billion m^3**
- **Discharge released at Jinghong: 2-3.5 times than natural conditions**
- **Increased water level along the Mekong mainstream: 0.18-1.53m**
- **Increased discharge along the Mekong mainstream: 602-1010m^3/s**
- **Maximum salinity in Mekong Delta decreased by: 15%-74%**
- **Minimum salinity in Mekong Delta decreased by: 9%-78%**

Case Study 2: Emergency Water Supplement in 2016

The news on MRC's official site point out that:

- **the release of water emergency water supplement from the Lancang dams eased the regional drought in 2016**
- **beacause of the emergency water releases from the Chinese dams upstream, the increased dry season flows that ultimately helped to mitigate potential impacts of the drought**

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The effects of Chinese dams on water flows in the Lower Mekong Basin

Vientiane Capital, Lao PDR, 6th Jun 2017

Since 1993, China has built six dams in the mainstream on the Upper Mekong Basin, known as the Lancang in China. Operations of these dams have stirred many concerns from the Lower Mekong Basin communities on how these dams will impact their river and livelihoods. With the two biggest storage dams of the cascade, Xiaowan and Nuozhadu, their impacts have often been in the news. The concerns include how changes in water flow (discharge) impact on fisheries, sediments, and downstream community livelihoods.

While the picture of the impacts is incomplete, the Mekong River Commission's (MRC) river monitoring arm points out that these Chinese dams do affect water flows in the Lower Mekong Basin, generally reducing the flow during the wet season and increasing it during the dry season.

Downstream water flow in the dry season increased, easing effects of droughts. Storage dams can contribute to increased flow during the dry season as they discharge water for energy production. For example, the release of water supplement from the Lancang dams eased the regional drought of 2016. The drought resulted in 16% less flows compared to the long term average. However, because of the emergency water releases from the Chinese dams upstream, that increased dry season flows that ultimately helped to mitigate potential impacts of the drought.

A total of 12.65 billion cubic meters of water was discharged from the Jinghong hydropower reservoir during the period of March to May 2016. These releases amounted to between 40 – 89% of flows along various sections of the Mekong River. The emergency water supplement increased water level or discharge along the Mekong mainstream to an overall extent of 0.18-1.53m or 602-1,010m^3/s.

If these emergency releases did not occur, flows would have been 47% lower at Jinghong, 44% lower at Chiang Saen, 38% lower at Nong Khai and 22% lower at Stung Treng. This additional flow has also alleviated salinity intrusion in the Mekong Delta.


Thanks for your attention !