Emergency response to **Baige Landslide Dam** on the Jinsha River in China

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Landslides at Baige Village

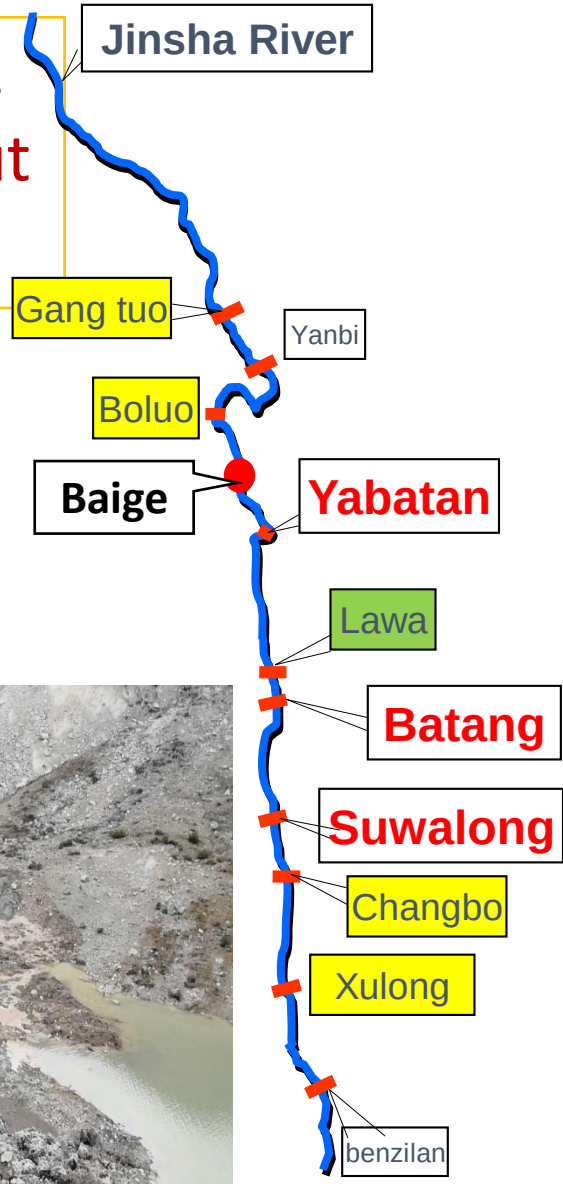
On Oct.10 and Nov. 3, 2018, twice, landslides blocked the Jinsha River, which is the upper reaches of the Yangtze River.

The big river was blocked by the landslide at Baige village, it caused widely societal concerns

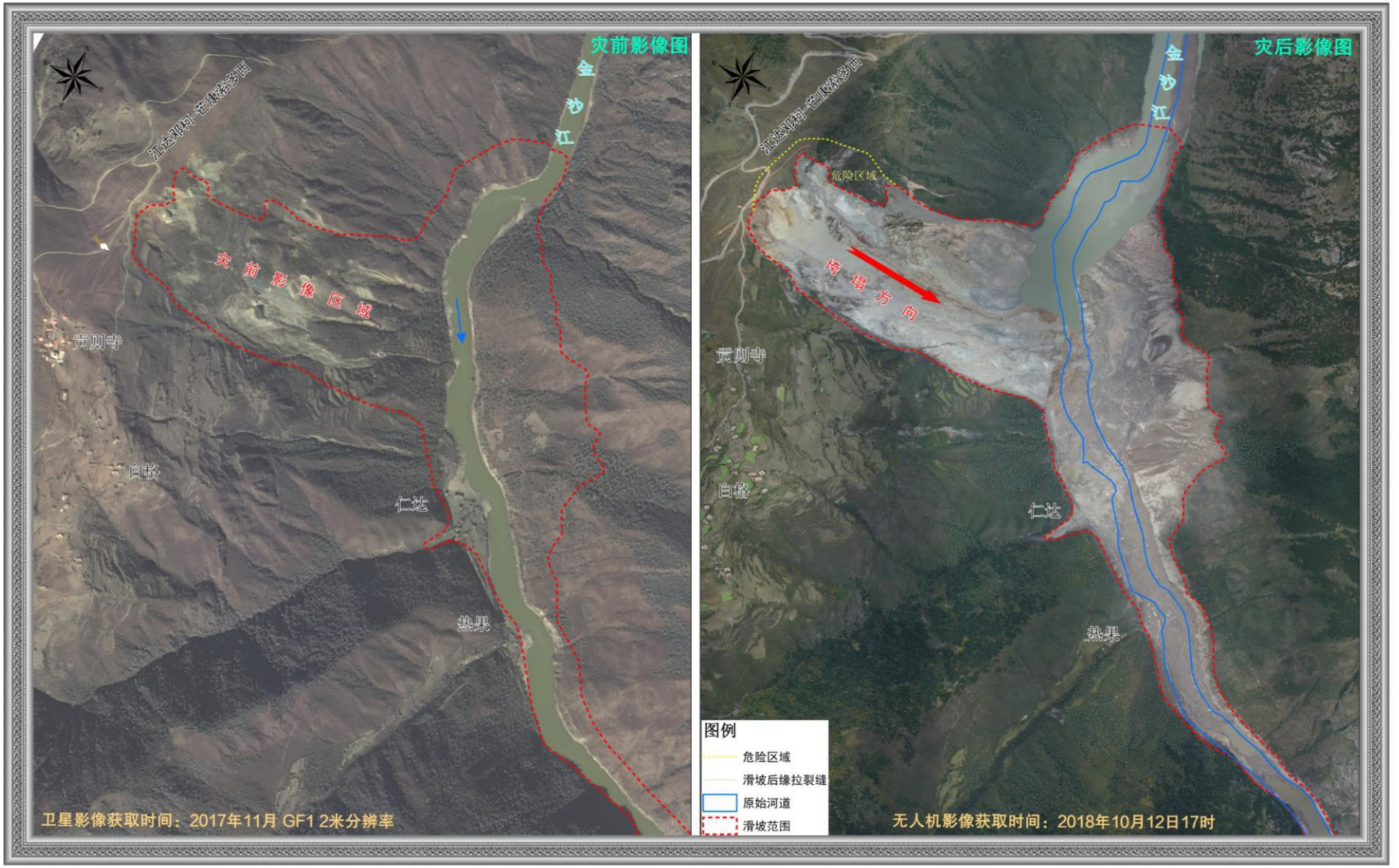
The 1st time: Baige Landslide Dam

The 1st landslide occurred on Oct.10 at 22:00. It is caused by the left bank landslides without rain and without earthquake.

The barrier roughly 1000m long and 200m wide and 60 to 120m high with volume of 25 million m^3.



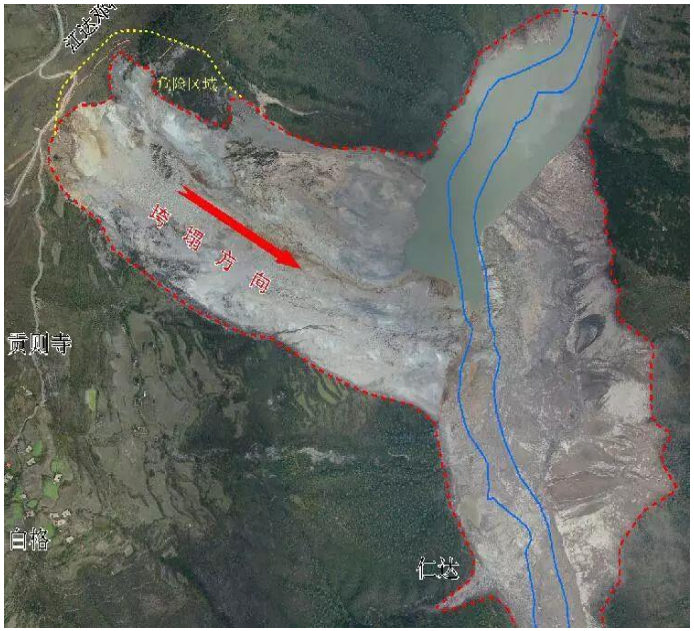
The 1st time: Baige Landslide Dam



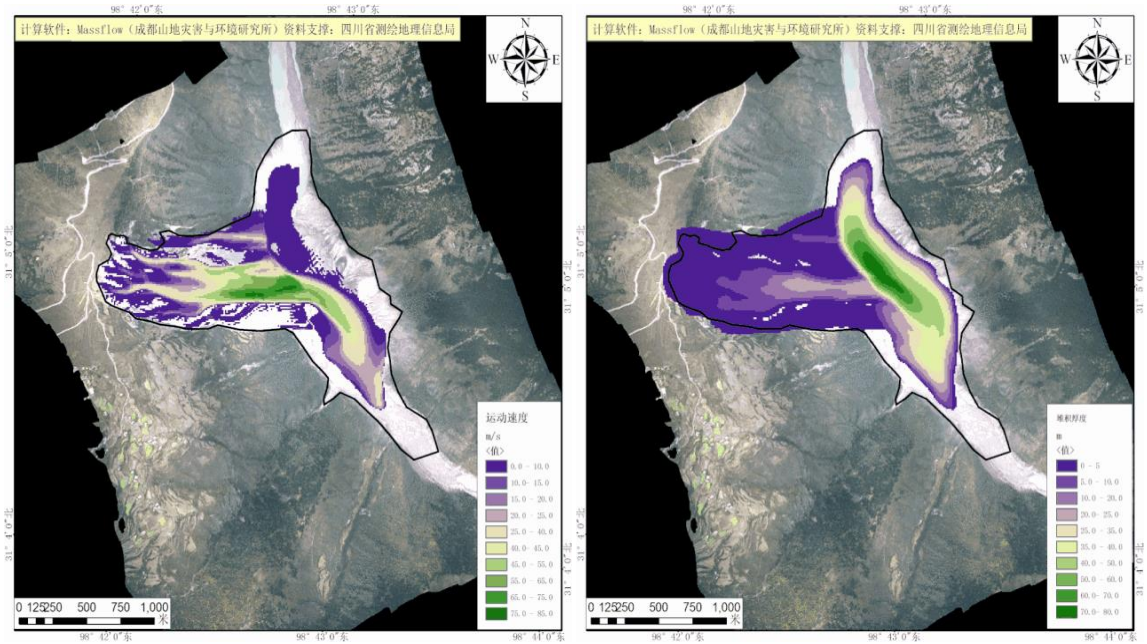
The 1st time: Baige Landslide Dam

According to the assessment of the barrier and the inflow, **the Barrier will be break naturally soon when overtopping.**

The overflow began at 17:20 on Oct. 12, and peak discharge **10,000m³/s** occurred at 5:00 on the next day.



First time landslide

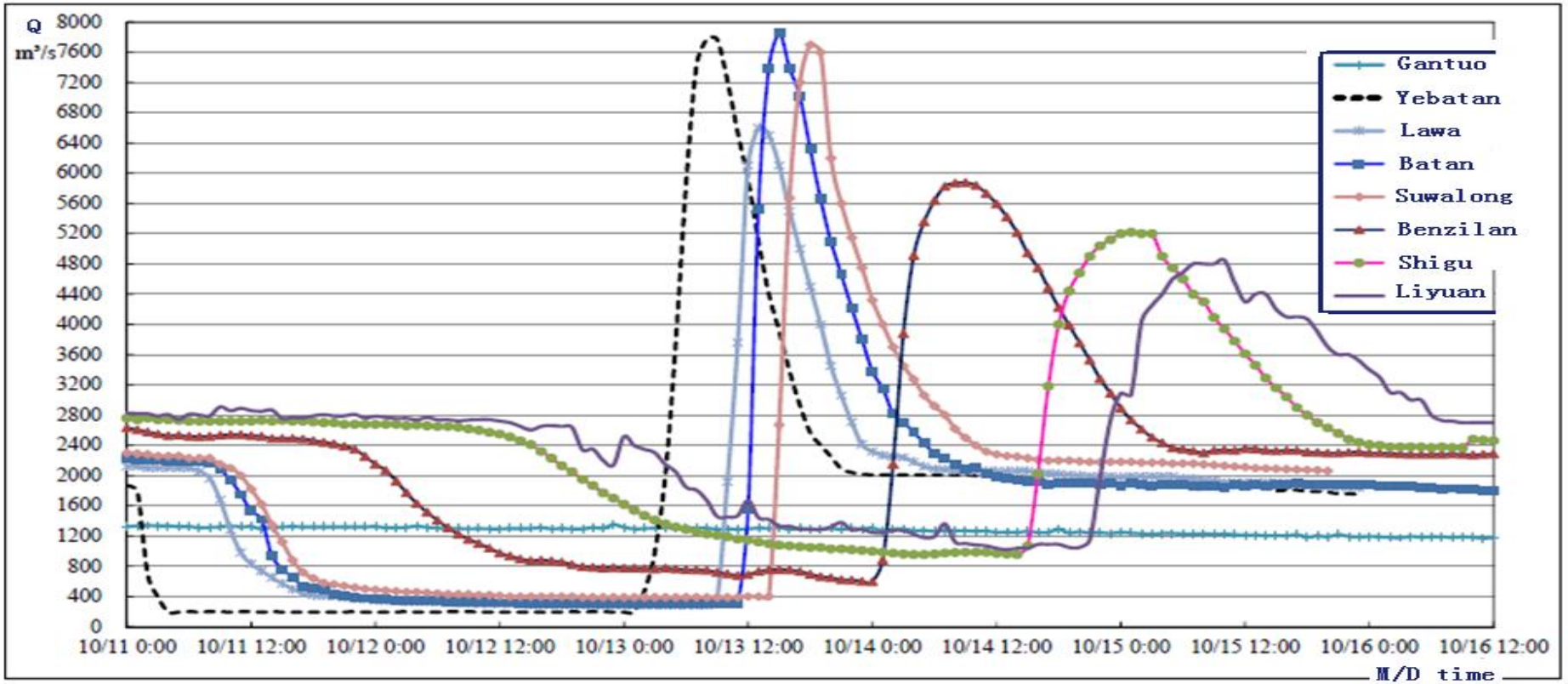


Evolution of landslide velocity and thickness

The 1st time: Baige Landslide Dam

As the flood routing to downstream, the peak discharge gradually decreases. It impact totally lasted 5days.

The flood routing hydrograph at each station were measured and recorded.



Measured flood Hygrograph after the Barrier break on Nov.13

The 1st time: Baige Landslide Dam

The 1st Baige landslide dam break caused locally some damages and losses.

Two diversion tunnels under constr. at the Yebatan were forced to flow through, flooding some roads and tunnels in the area.

The peak discharge reduced to 5,700 m^3/s from 7,700 m^3/s, due to the Suwalong cofferdam retains flood.

The 2nd time: Baige Landslide Dam

The 2nd landslide occurred at 17:40 on Nov. 3, 2018 at the same site on Jinsha River.

The volume of landslides 310 million m^3 with the residual material of 1st landslide. The top El. of the Barrier is 2,966m, water storage capacity 775 million m^3, which will be 3.5 times of the 1st barrier lake.

Much more danger!

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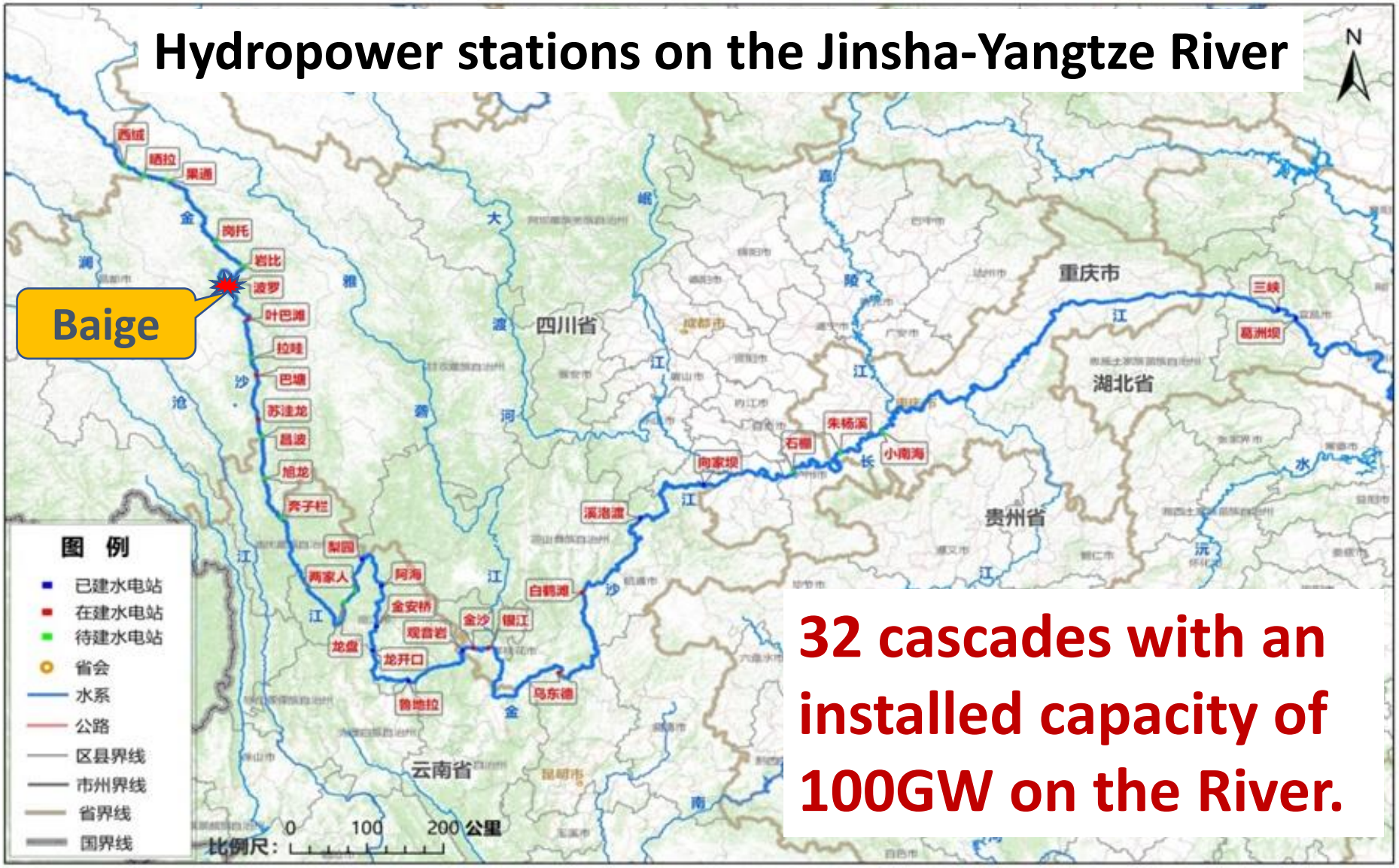
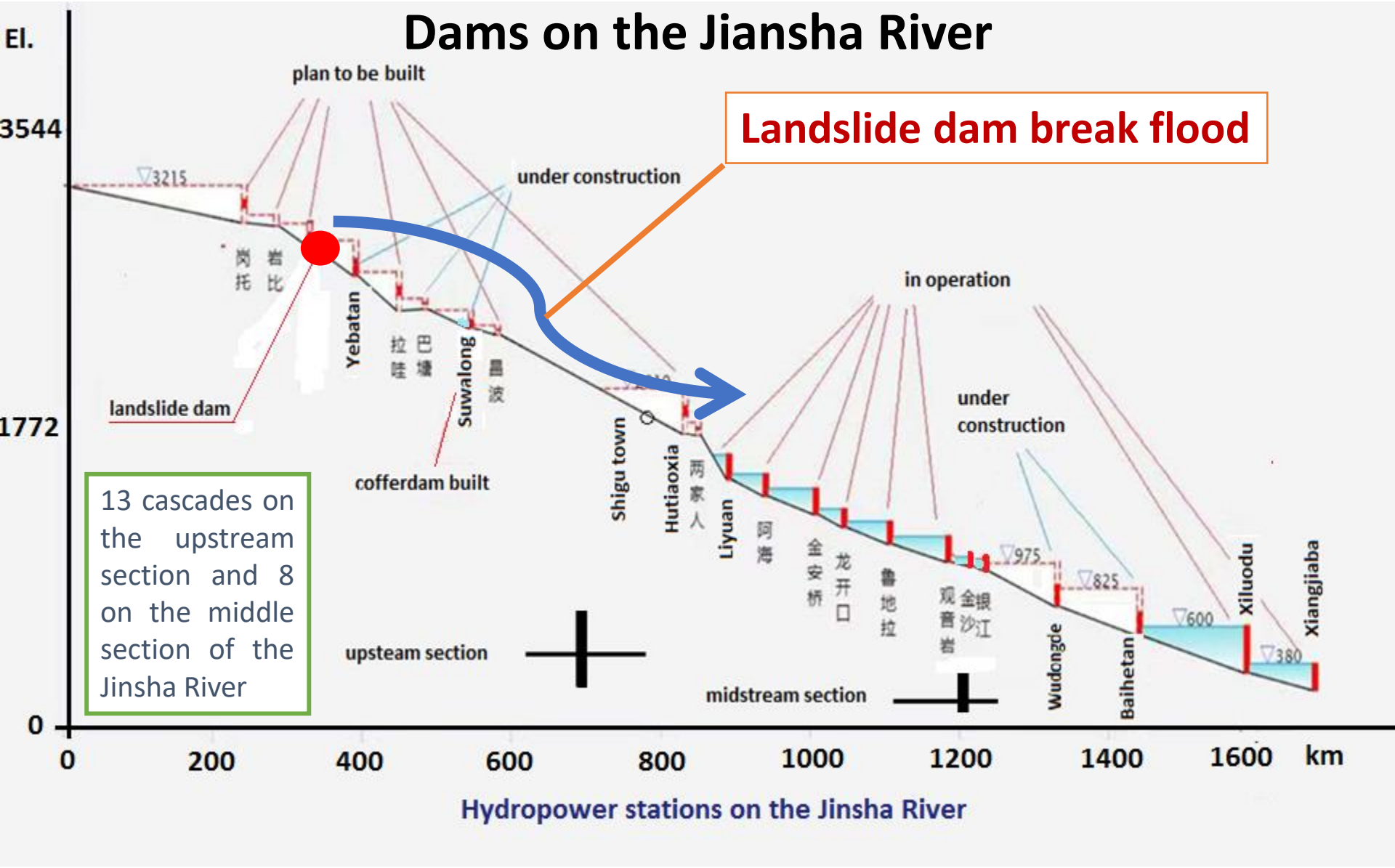


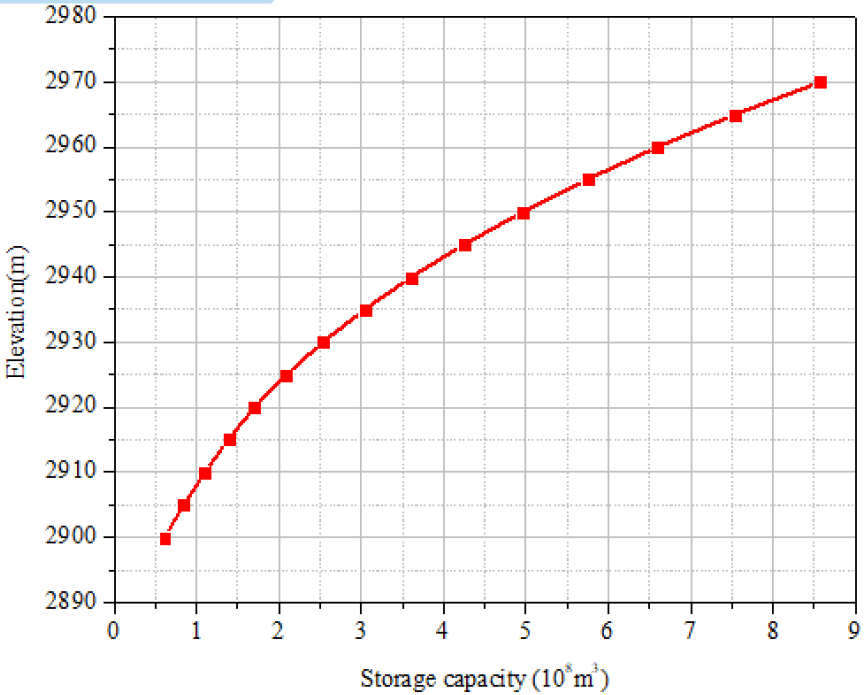
Emergency Decision-making Support



Emergency Decision-making Support

1. Acquisition of basic information

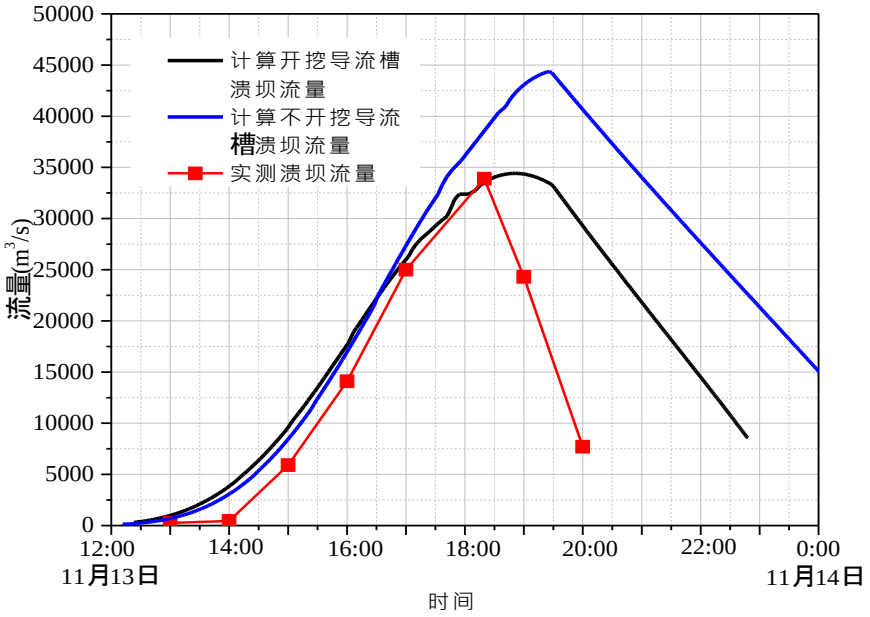
Meteorological, hydrological, topography, geological, Multi-sensor satellite remote sensing information…….



Emergency Decision-making Support

2. Landslide dam risk analysis

Cases	Peak flood (m^3/s)	Arrival time after overflow (hr)	flow velocity at the ditch (m/s)
A-1	44670	7.6	9.0
A-2	37300	8.5	8.7



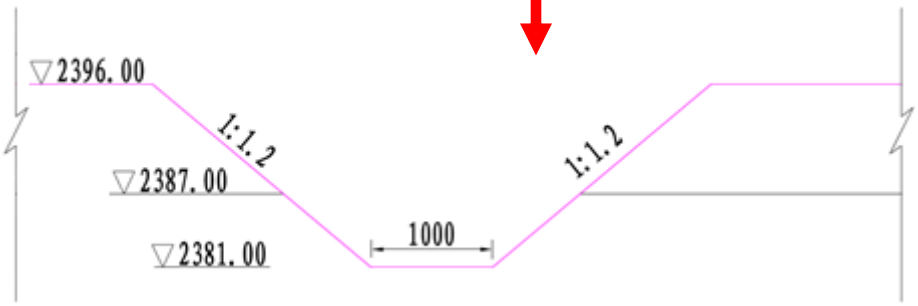
After the risk analysis, it is predicted that the flood peak is about 37,000 to 45,000 m^3/s without manual intervention.

Emergency Decision-making Support

3. Making emergency disposal plan

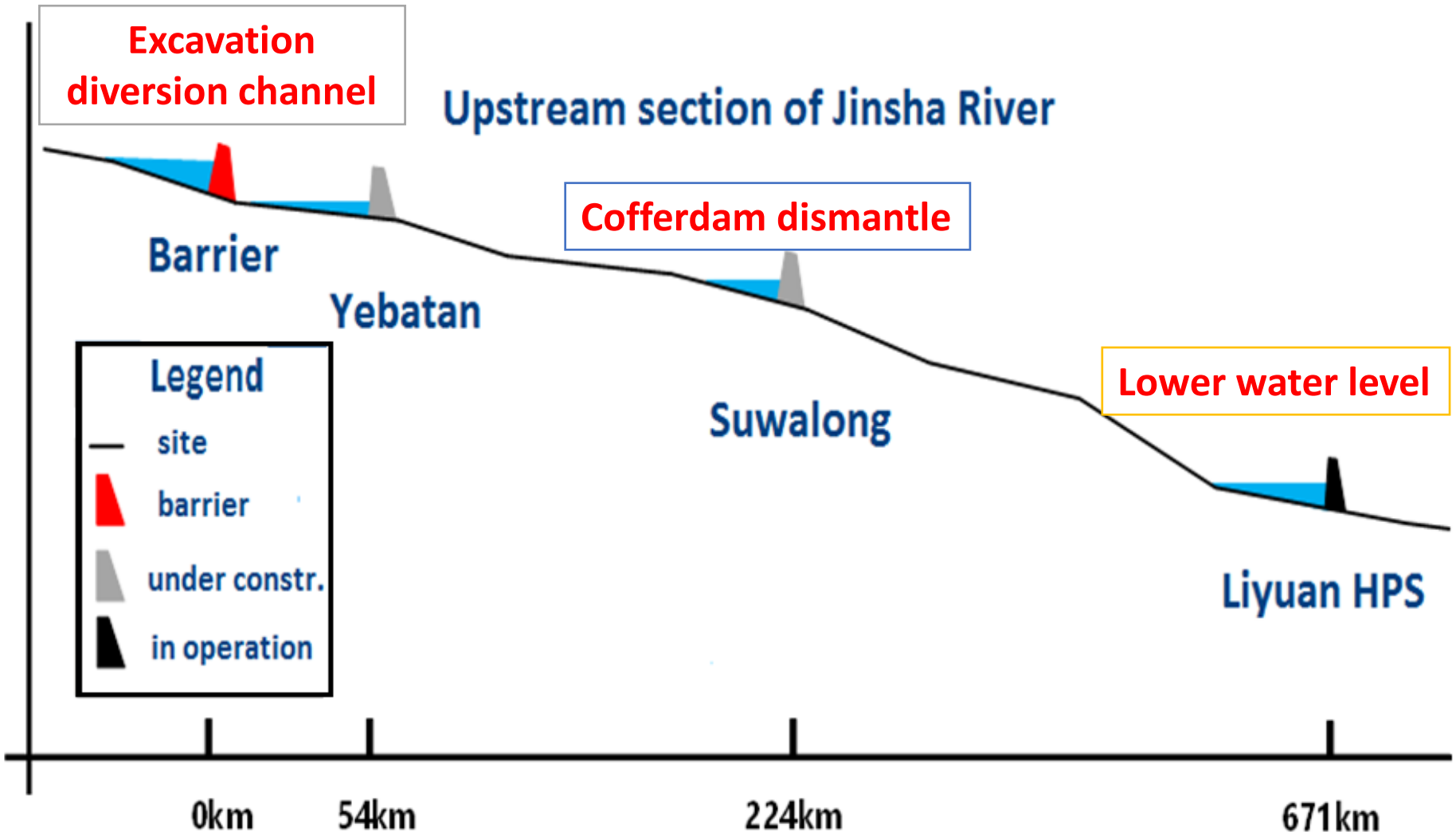
On Nov. 4, main three suggestions:

1) Artificial intervention---Excavation diversion Channel
2) Suwalong cofferdam dismantle
3) Liyuan reservoir emptying in advance.



The design plan of Suwalong cofferdam dismantle

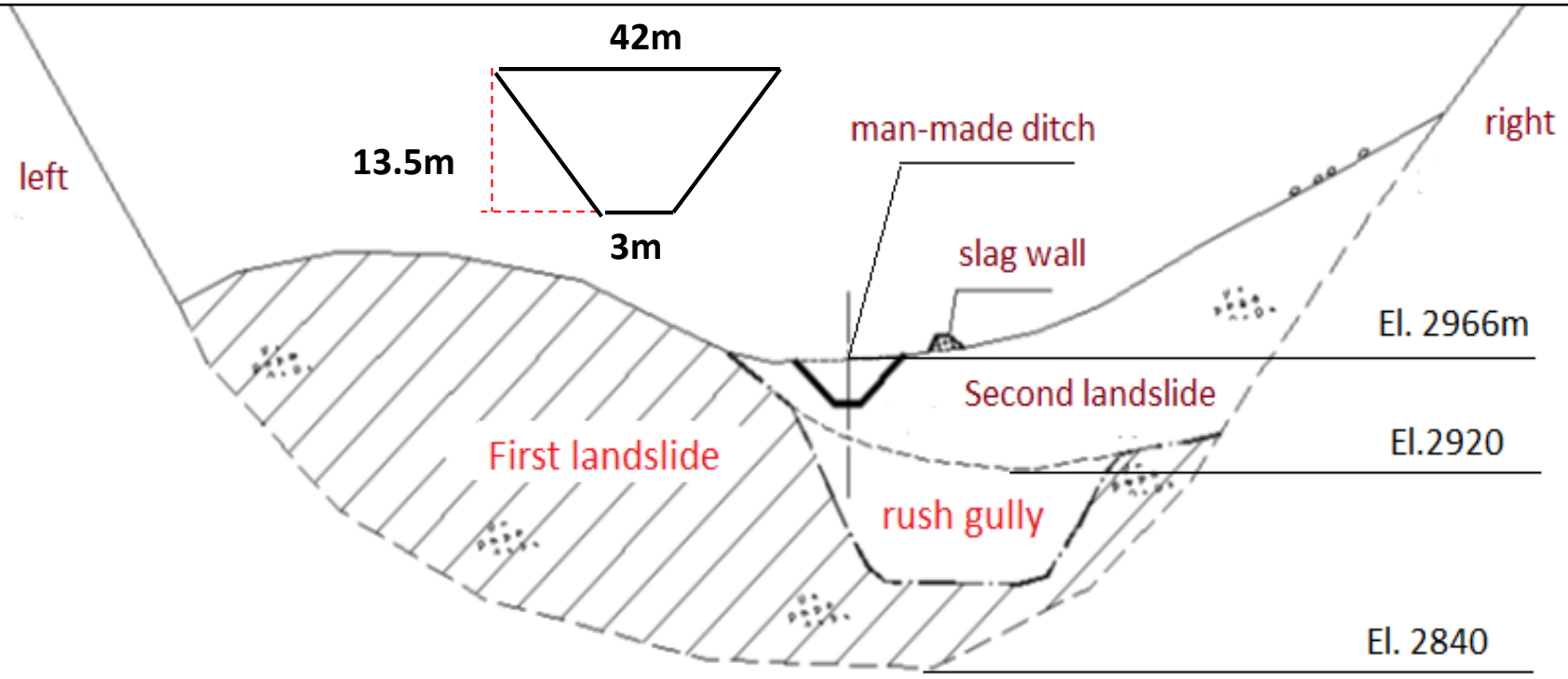
Emergency Decision-making Support



Emergency Decision-making Support

✓ Make emergency disposal plan

it is predicted that the barrier will not collapse naturally . Greater risks is gathering day by day. So a man-made diversion channel scheme is essential and indispensable for Emergency treatment.



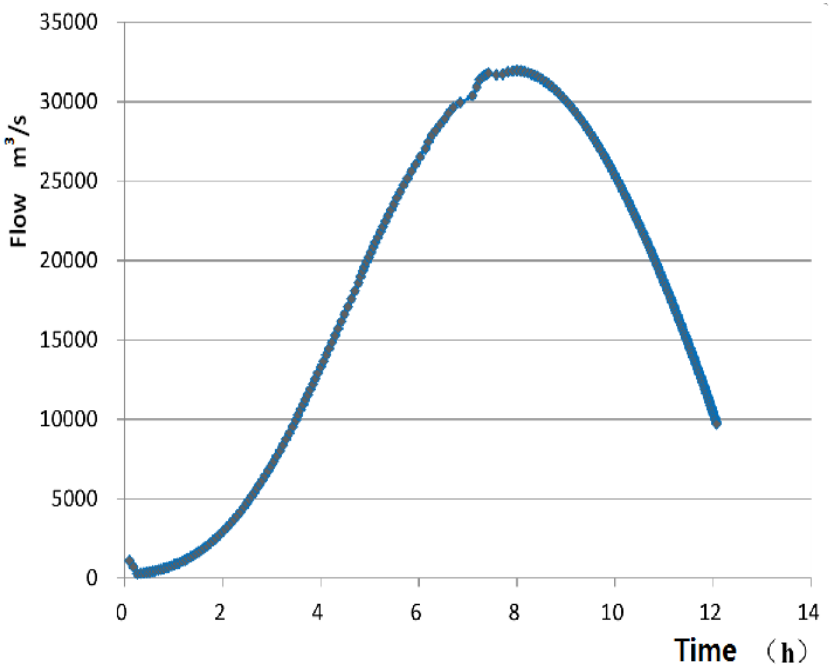
Emergency Decision-making Support

✓ Landslide dam risk analysis

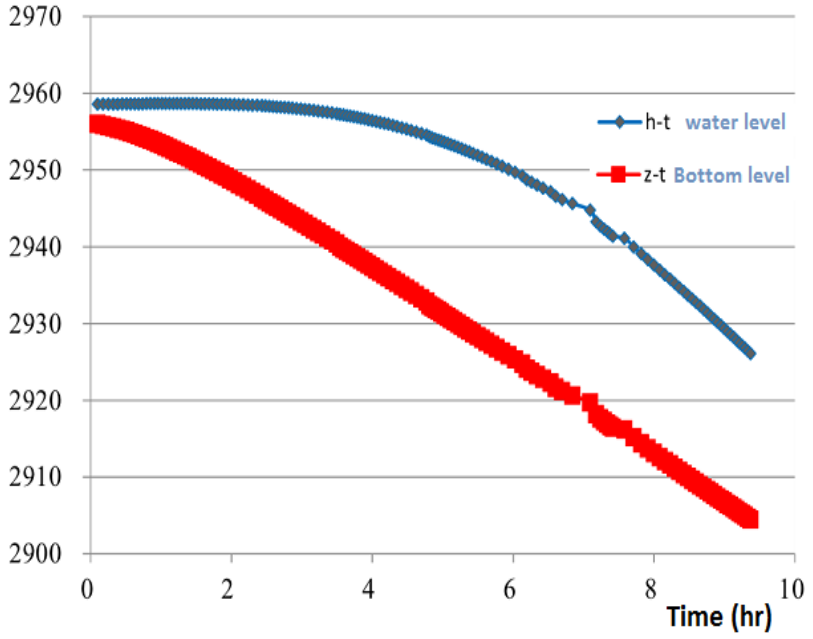
水电水利规划设计总院
China Renewable Energy Engineering Institute

After cutting the ditch, the landslide dam breach flood max. 30,000 m^3/s.

金沙江白格堰塞湖
溃坝洪水计算分析报告



Flood hydrograph calculated by Xingbo Zhou on Nov 4 , 2018

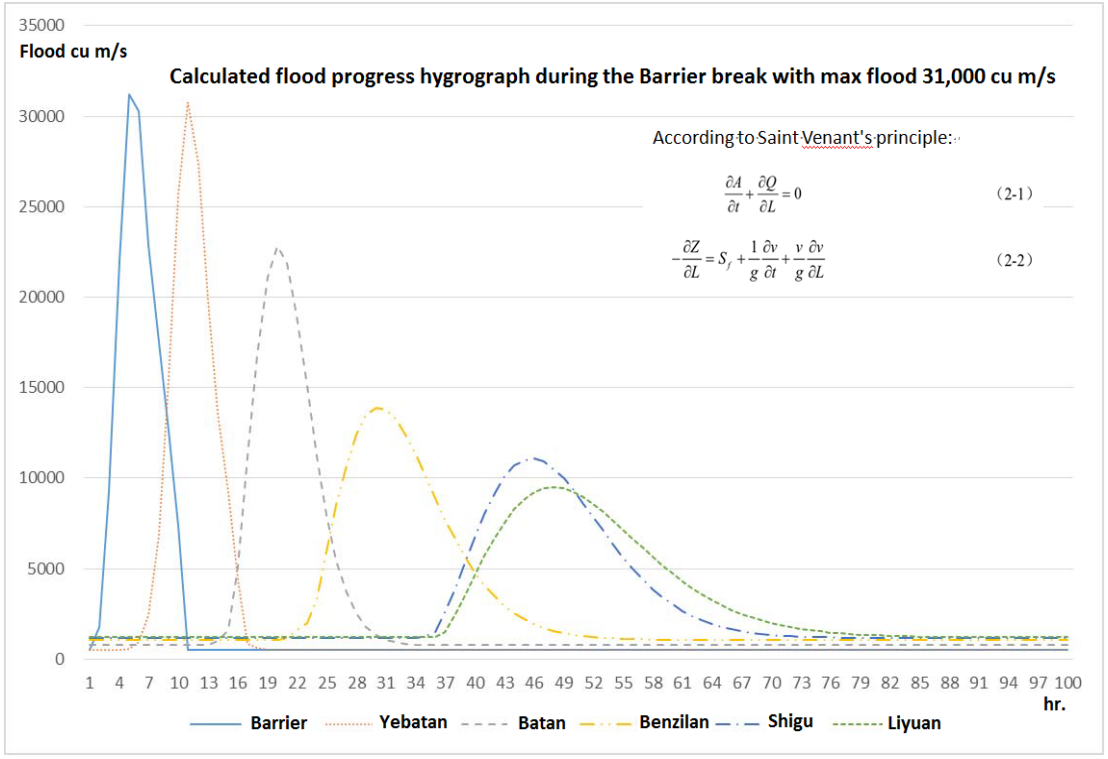


Calculated water level and bottom level of the trench by Xingbo Zhou

Emergency Decision-making Support

✓ Landslide dam risk analysis

Then, analyzed the flood routing hydrography downstream



According to Saint Venant's principle:

$$\frac{\partial A}{\partial t}+\frac{\partial Q}{\partial L}=0 \qquad (2\text{-}1)$$

$$-\frac{\partial Z}{\partial L}=S_f+\frac{1}{g}\frac{\partial v}{\partial t}+\frac{v}{g}\frac{\partial v}{\partial L} \qquad (2\text{-}2)$$

中国电建 POWERCHINA

金沙江　　白格堰塞湖

溃堰洪水演进分析计算报告

中国电建集团昆明勘测设计研究院有限公司
KUNMING ENGINEERING CORPORATION LIMITED

二〇一八年十一月

Emergency Decision-making Support

✓ Make emergency disposal plan

The government issued an emergency evacuation notice from very beginning based on the results calculated.

The information about the emergency treatment to the Barrier, rescue and evacuate were updated at any time by Newspaper, Wechat, Network, Radio and Mobile phone.

云南省特殊水情

第 96 期

云南省水文水资源局……2018 年 11 月 14 日 4 时 30 分

金沙江堰塞湖 11 月 13 日溃坝洪水云南段水情预警

受金沙江干流白格堰塞湖溃坝洪水影响，四川省巴塘县巴塘水文站 11 月 13 日 23 时 10 分起涨，起涨流量 178m^3/s，14 日 2 时出现洪峰水位 2494.91m，相应流量 20900m^3/s。根据预报方案预测，金沙江干流白格堰塞湖溃坝洪水 14 日 5 时左右进入云南，14 日 11 时左右迪庆州德钦县奔子栏水文站起涨，14 日 23 时左右丽江市玉龙县石鼓水文站起涨，云南省境内各主要防护断面洪峰水位、流量、洪峰出现时间预测值见附表。

金沙江堰塞湖 11 月 13 日溃坝洪水迪庆、丽江影响区主要防护对象洪水预测成果

Emergency Decision-making Support

✓ Implementation process

5 days later (on 8th Nov), first machine arrived at the top of the Barrier.

The man-made diversion channel was built at 17:00 on 11th Nov., 2018.

Emergency Decision-making Support

✓ Implementation process

Man-made diversion channel under construction from 8th to 11th Nov.

Emergency Decision-making Support

✓ **Implementation process** Suwalong Cofferdam dismantle

If the cofferdam is not removed, it will be also breach, and the water volume will be superimposed to the Barrier breach flood. Dismantle began on 7th November.

Emergency Decision-making Support

✓ **Implementation process**

Suwalong Cofferdam dismantle

Emergency Decision-making Support

✓ **Implementation process** Suwalong Cofferdam dismantle

It was finished to remove cofferdam on Nov.10

Emergency Decision-making Support

✓ Drainage process

At 5:00 am on 12th, the water level of the Baige barrier lake rose to the bottom of the man-made diversion channel.

At 8:00 on 13th, the Dam came into the breach stage, corresponding to the water level of 2955.76m with water storage of 0.6 billion cu m.

At 18:20 on 13th, the dam breach flood reached the peak discharge, measured to be 33,900 m^3/s. in 10hr of the beginning of overtopping)

Baige Landslide dam Break 13 Nov 2018

Emergency Decision-making Support

✓ **Flood routing**

Yebatan HPS site

far away **54km** to the Barrier

Emergency Decision-making Support

✓ Flood routing

Suwalong
far away
224km to
the Barrier

Fmax
19,800m^3/s
at 3:50 am on
14th Nov.

Emergency Decision-making Support

Emergency Decision-making Support

✓ **Flood routing**

Benzilan Hydrologic station

far away **380km** to the Barrier

Emergency Decision-making Support

✓ **Flood routing**

Shigu Town

far away **560km**
to the Barrier

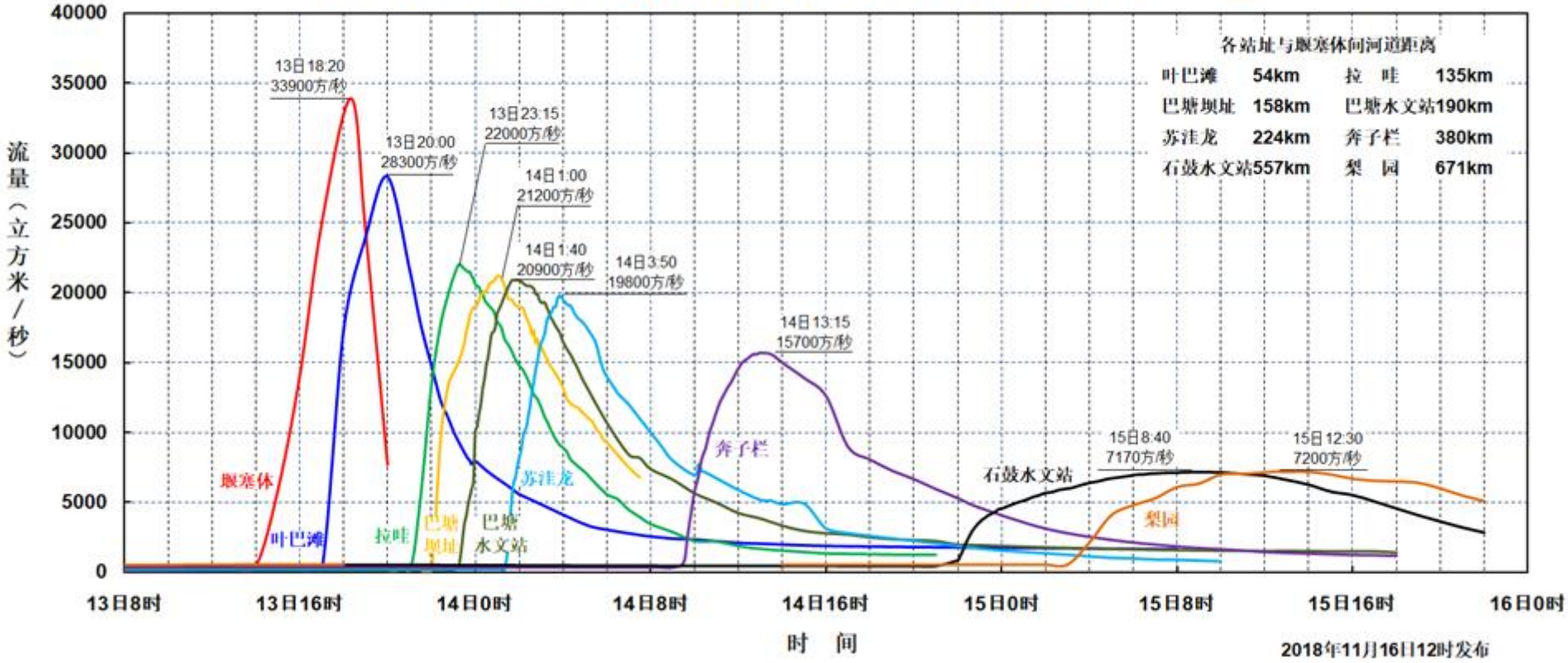
✓ Flood routing

Emergency Decision-making Support

✓ Flood routing

At least 7 bridges on the Jinsha River, hundreds national roads and other major infrastructures by the side of the River were damaged during 13-15 Nov., 2018.

Measured flood hydrograph at the dam sites



The flood rapidly advanced to the downstream. The flood peak discharge to the Yebatan reached 28,300 m^3/s at 20:00 on 13th. At 1:00 am on 14th, the flood peak discharge at the Batan station was 20,900 m^3/s. The flood at Suwalong reached its peak at 19,800 m^3/s at 3:50 am on 14th Nov. The inflow to Liyuan reservoir reached the maximum flood of 7200 m^3/s at 12:30 on 15 Nov.

Emergency Decision-making Support

✓ Consequences

Yunnan Province suffered the most losses, followed by Sichuan and Tibet, approximately 1.2 billion, 0.6 billion and 0.5 billion USD respectively. With losses of hydropower stations under construction , **the totally losses were 3.0 billion USD.**

✓ Consequences


工程
助推藏区发展

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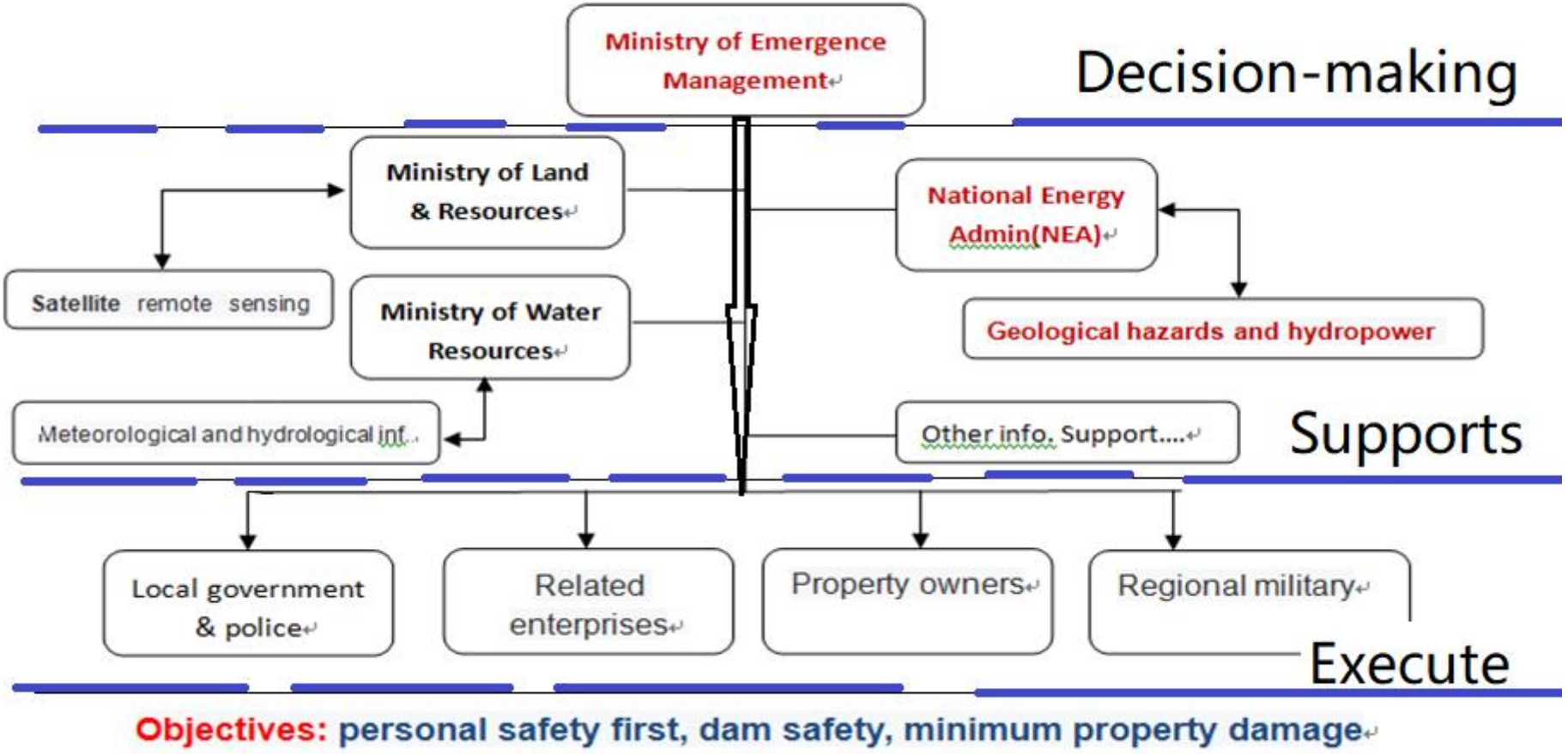
Considerations related to the river safety

Considerations related to the river safety

- ✓ **Effective emergency management mechanism is critical.**



Considerations related to the river safety

✓ Rethink to the flood standard

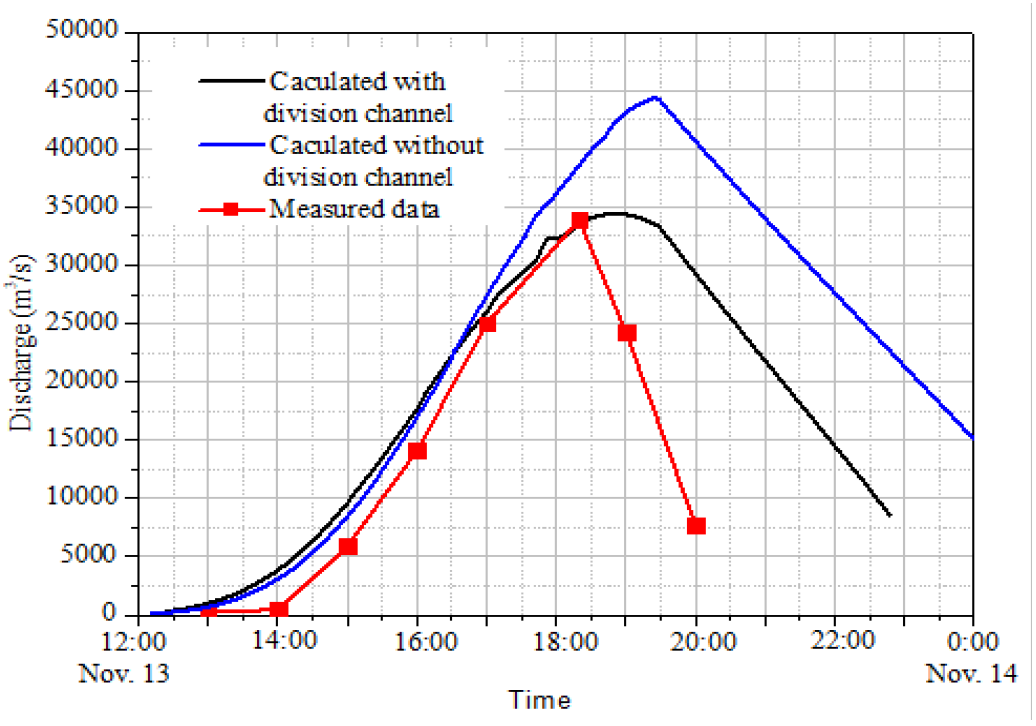
The maximum flood peak 33,900 m^3/s occurred after landslide dam breach Nov. 12, 2018. The Max. flood much more than PMF for the upstream reaches and more than 1000 year flood for the middle reaches of the Jinsha river.

Station	Stage	Dam type	Check flood standard	Check peak discharge (m^3/s)	Dam breach discharge (m^3/s)
Yebatan	Under Constr.	Concrete arc dam	5000y	10100	28300
Lawa	Prepare Constr.	CFRD	PMF	11900	22000
Batan	Under Constr.	asphalt concrete core dam	5000y	10500	20900
Suwalong	Under Constr.	asphalt concrete core dam	PMF	12500	19800

Considerations related to the river safety

✓Strengthening emergency response capacity

There was higher calculation accuracy of the landslide dam break flood hydrograph, but a big deviation in the flood routing of the downstream channel, which needs to be improved.



Considerations related to the river safety

✓ **Accelerate dams and reservoirs construction**

➢ **Building dams and reservoirs on the Rivers, It** is not only beneficial for providing the safety for flood control, water supply, but also beneficial for prevention and mitigation of geological hazards unascertained.

Better dams, better life!

Thanks for your time