



An Overview of GLOF Hazards and Risk Reduction Initiatives in Bhutan



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Outline

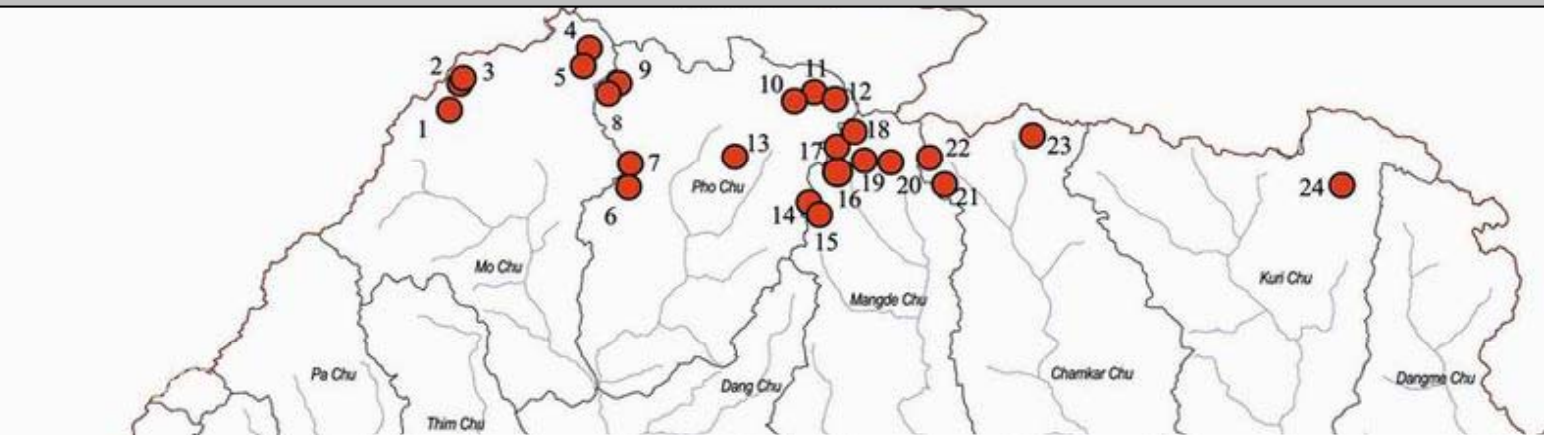
1. Introduction on GLOF hazards, risks and vulnerabilities
2. The 1994 and 2015 outburst from Lugge Tso (lake) and Lemthang Lake and its impact
3. Policy initiatives and institutional mechanisms in Disaster Risk Reduction (DRR)
4. GLOF risk reduction programs
5. Conclusion

GLOF Hazards in Bhutan

- 677 glaciers and 2,794 glacier lakes in the Bhutan Himalayas (ICIMOD & DGM, 2001)
- 25 glacier lakes potentially dangerous
- 21 outburst cases in Bhutan (SATREPS Project, 2012)
 - 17 events between 19th century and the 1970s
 - 4 cases of outburst in the last 40 years
- 28 June 2015, Outburst of Lemthang Tsho (Latest GLOF)

Potentially Dangerous Lakes

Out of **2794** glacial lakes, **25** has been identified as potentially dangerous lakes.



Pho Chu sub-basin: most vulnerable valley in terms of GLOF disaster

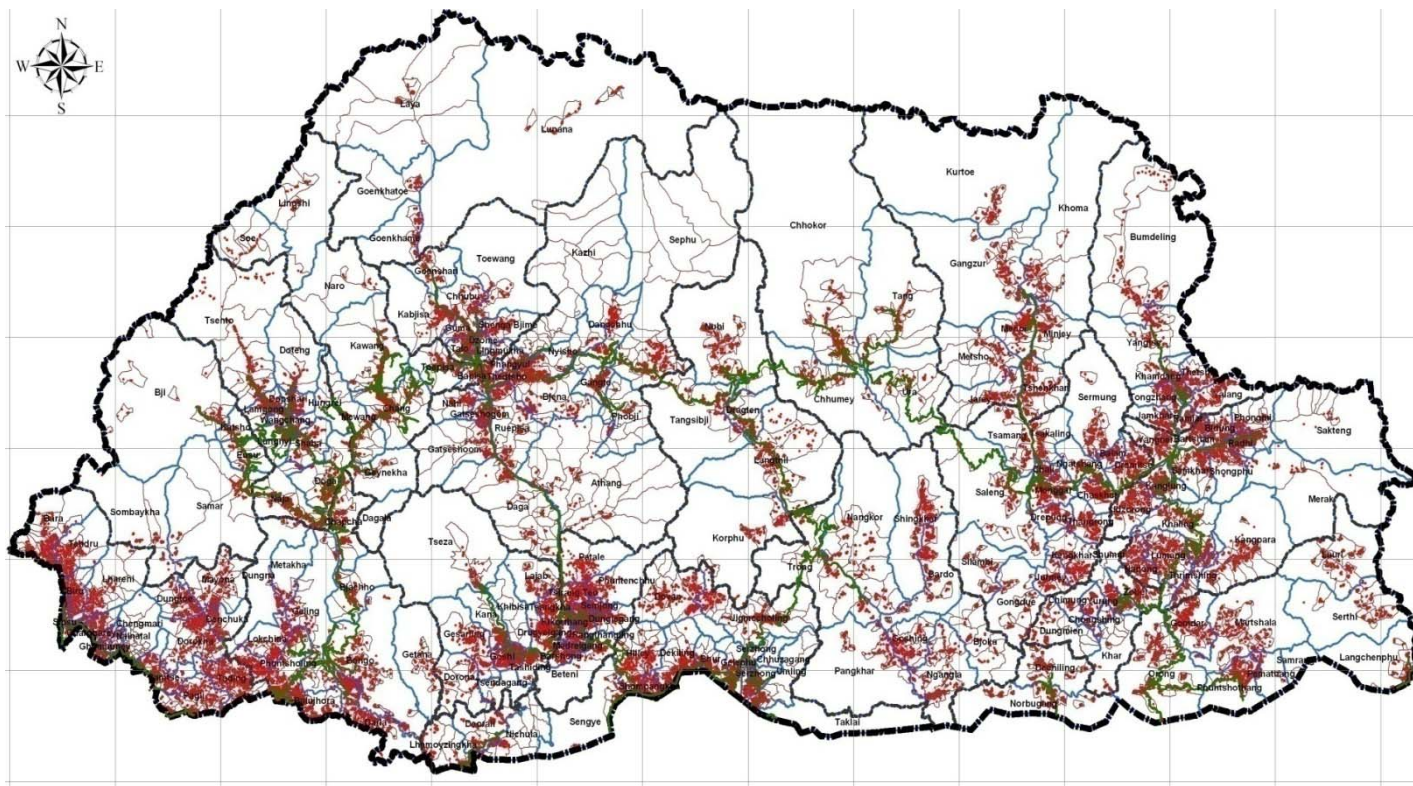


Recently studies (DGM-JICA/JST) concluded Raphstreng and Thorthomi lake as the two potentially dangerous glacier lakes in Bhutan

- Potentially dangerous
- Basin boundary
- River
- International boundary

GLOF Risk & Vulnerability

- Over 70% of settlements located along the drainage basins
- Impacts downstream across the border

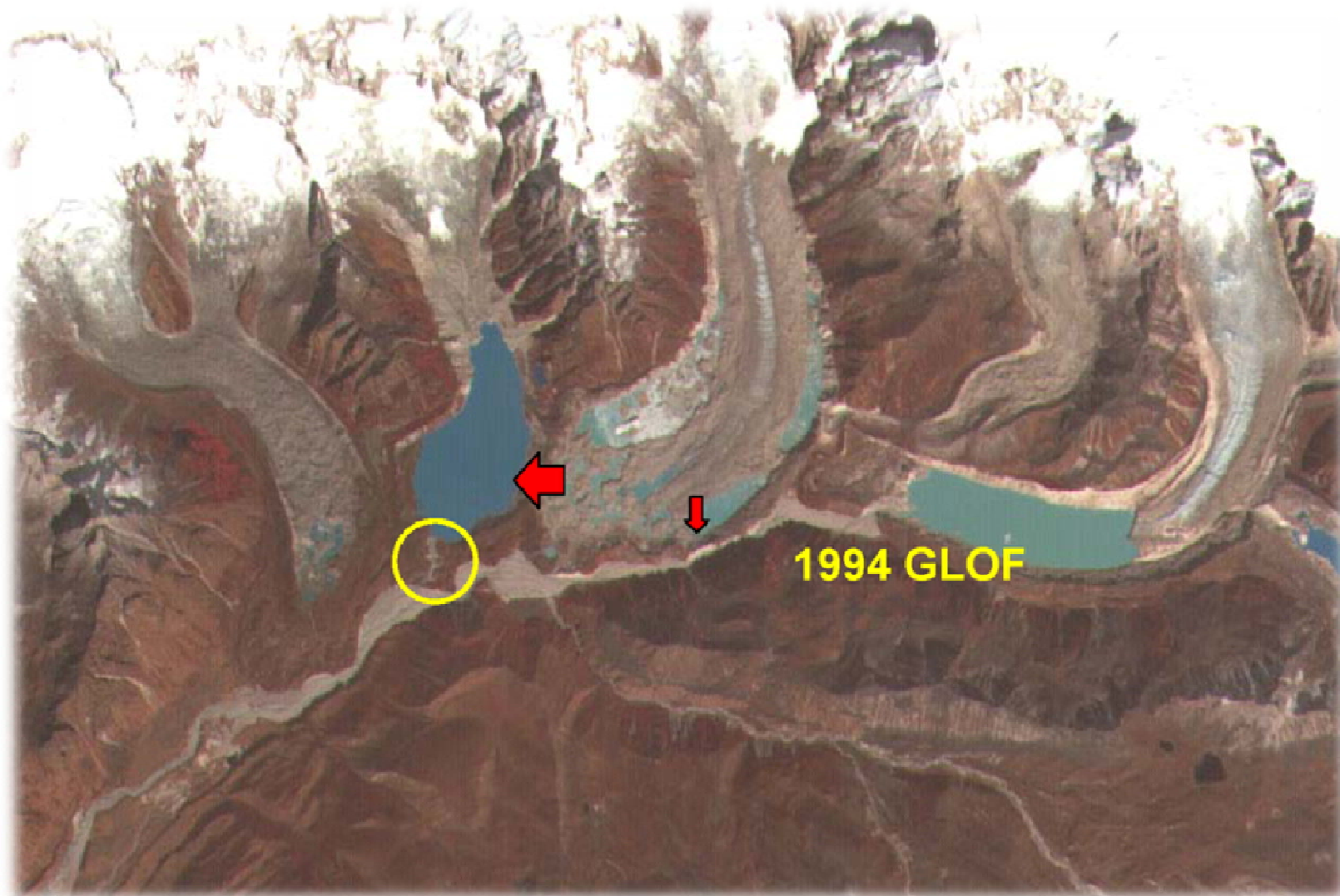


Infrastructures downstream



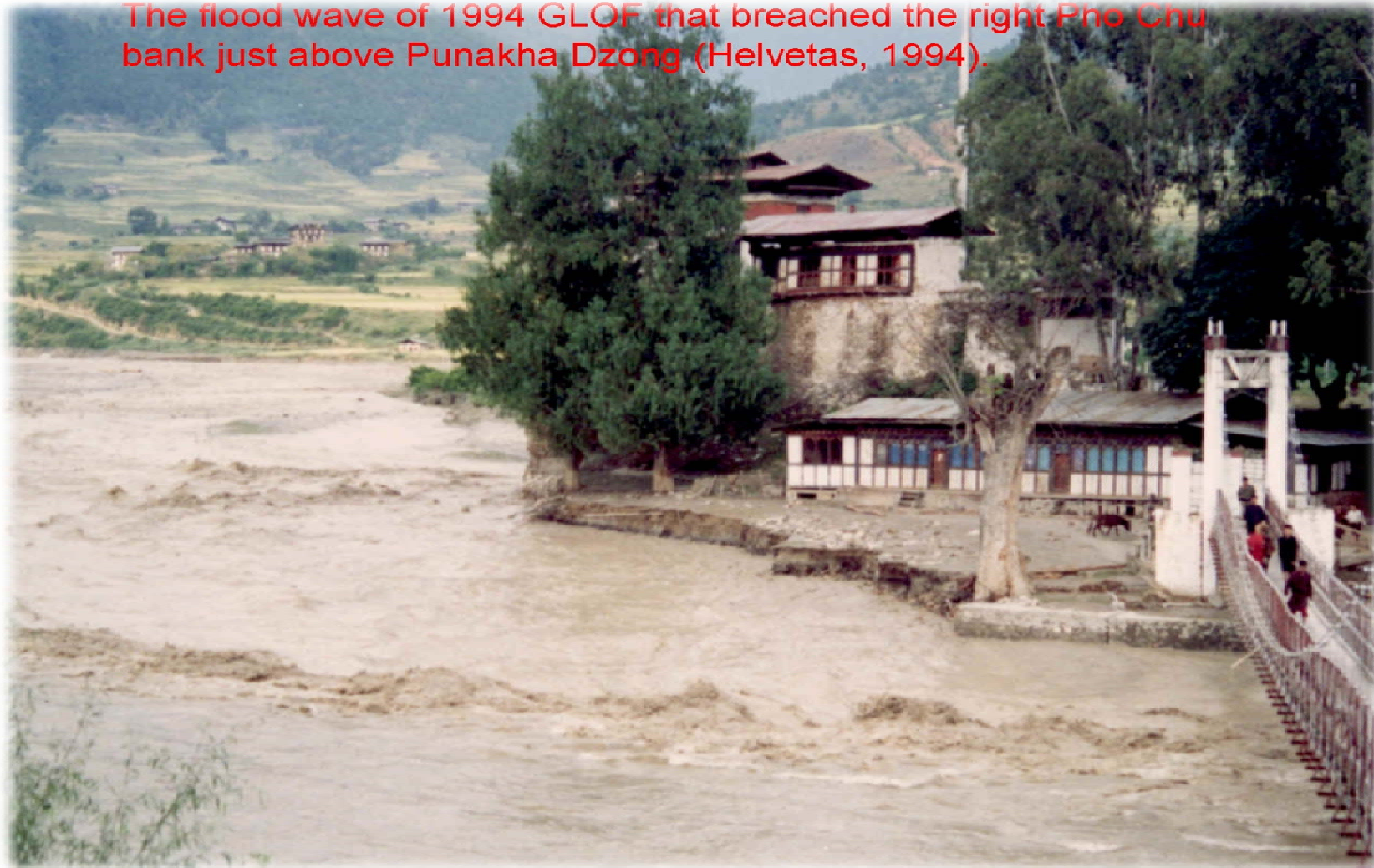
No	Projects	Capacity MW	Start Date FY	COD FY
1.	Punatsangchhu-I	1,200	2009	2015
2.	Mangdechhu	720	2010	2017
3.	Punatsangchhu-II	990	2010	2019
4.	Sankosh Reservoir	2500	2011	2020
5.	Kuri-Gongri	1,800	2012	2020
6.	Amochhu Reservoir	620	2012	2018
7.	Kholongchhu	650	2012	2018
8.	Chamkharchhu-I	670	2012	2018
9.	Wangchhu	600	2012	2018
10.	Bunakha Reservoir	180	2012	2018
11.	Nikachhu	208	2012	2017
12.	Khomachhu	327	2014	2017
13.	Rotpashong	918	2012	2019
14.	Gamri	102	2013	2017
15.	Dagachhu	114	2009	2013
	Total	13,159		

The October 7, 1994 Lugge Tsho (Lake) Outburst



Impacts downstream

The flood wave of 1994 GLOF that breached the right Pho Chu bank just above Punakha Dzong (Helvetas, 1994).

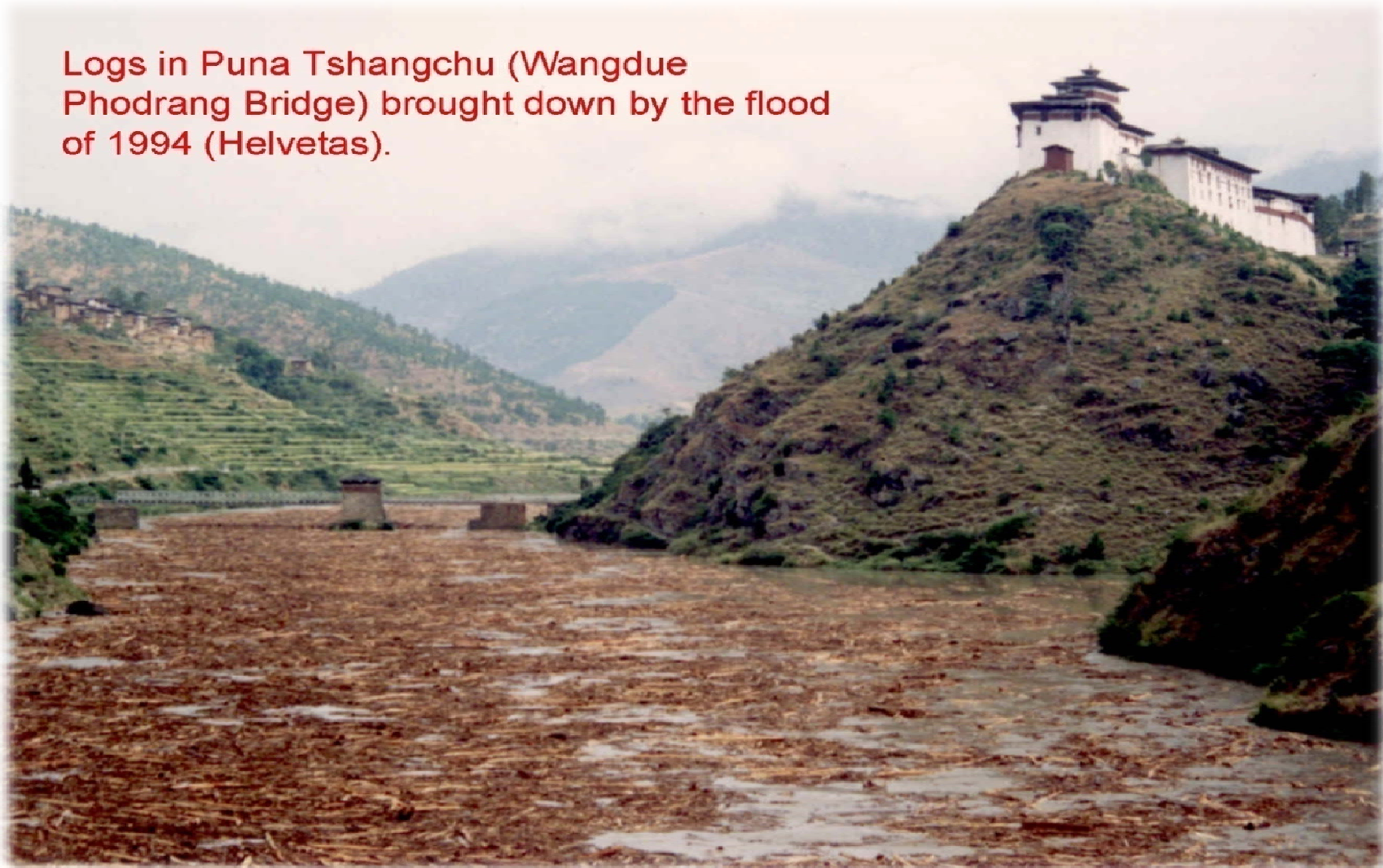


Impacts downstream



Impacts downstream

Logs in Puna Tshangchu (Wangdue Phodrang Bridge) brought down by the flood of 1994 (Helvetas).



Lemthang Lake Outburst on 28 June 2015

Location: 28° 4' 1"N; 89° 34' 52"E

Elevation: 4290 msl

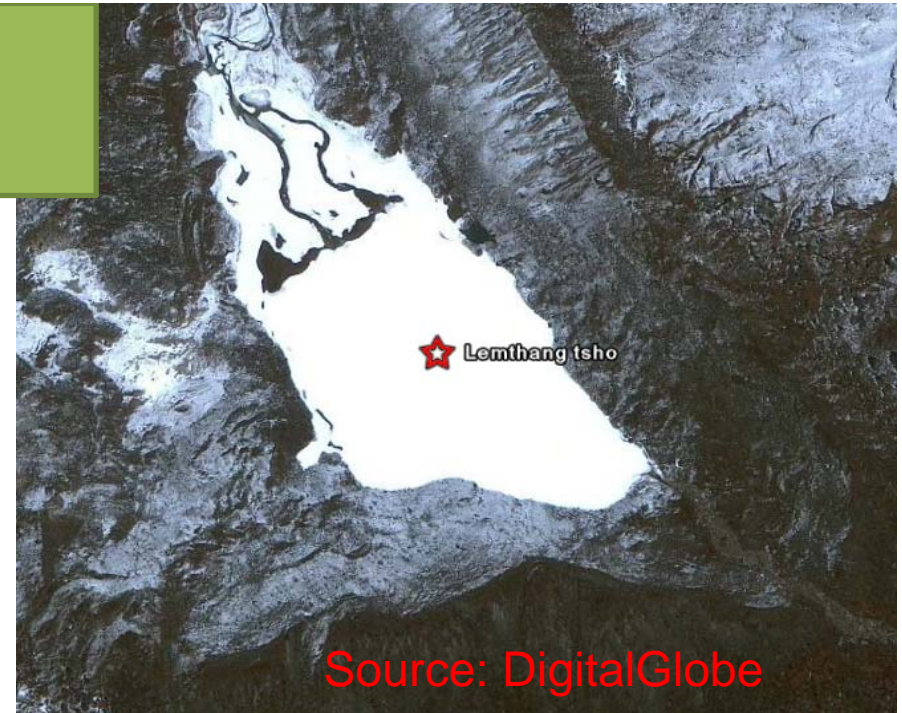
Length: 445m

Area: 0.076 sq km

Avg. depth: 6.29m

Deepest point: 14.42m

Volume: 0.37 million m³



Lemthang Tsho: Before GLOF



Photo taken in May 2015

Source: Google photo: Sebastian Kammer, May

Lemthang Tsho: After GLOF



Empty

Photo taken in July 2015

Loss and damages from Lemthang GLOF

Damages	No./acre	Estimate loss (Nu. Million)	Source
Bridges washed away	4 Nos	0.976	Laya Gewog Administration
Land affected	1 acre		
Horse lost	4 Nos		
Timber washed away	148 pieces		
Landslides	3 Nos		Observation

Policy and Institutional interventions

- Up-gradation of erstwhile Division of Disaster Management to Department of Disaster Management in 2008
- Development of National Disaster Risk Management (NDRM) framework in 2008
- Creation of Division of Glaciology under Department of Geology and Mines in 2010
- Development of Disaster Management Act
- Disaster mainstreamed in 11th Five Year Plan (2013-2017)

Reducing Climate-Induced Risks and Vulnerabilities from GLOF



Climate Change risk advocacy and awareness: Department of Disaster Management



Installation of GLOF early warning system: Department of Hydro-Met Services

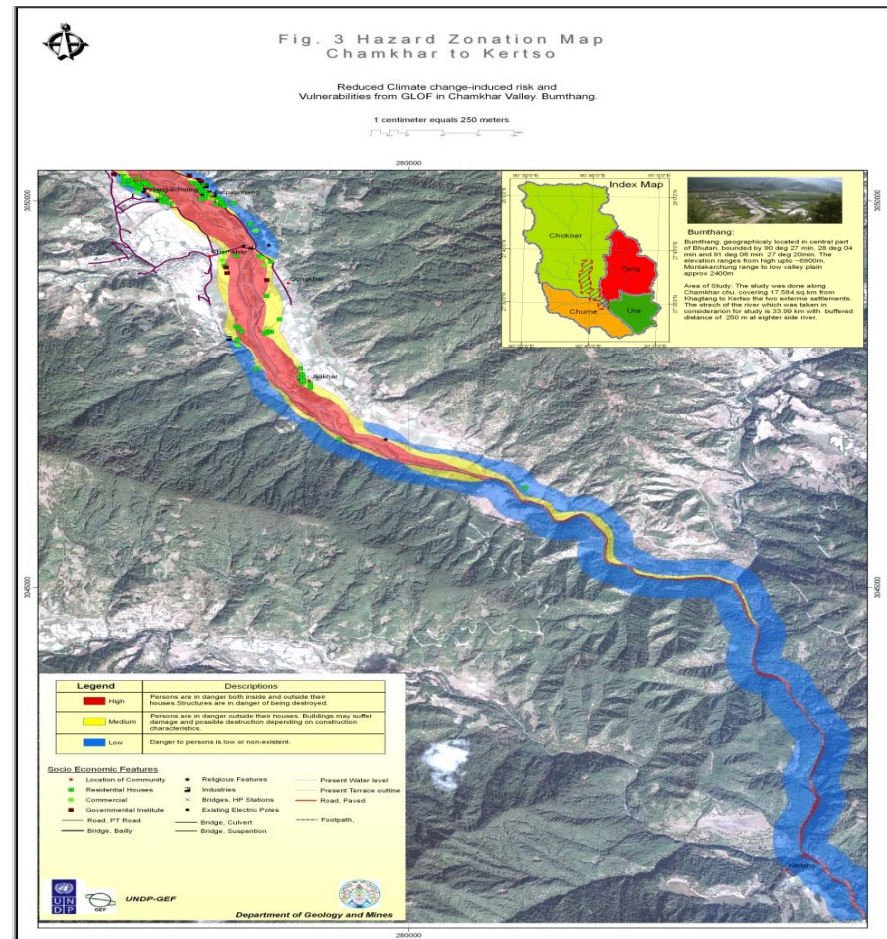
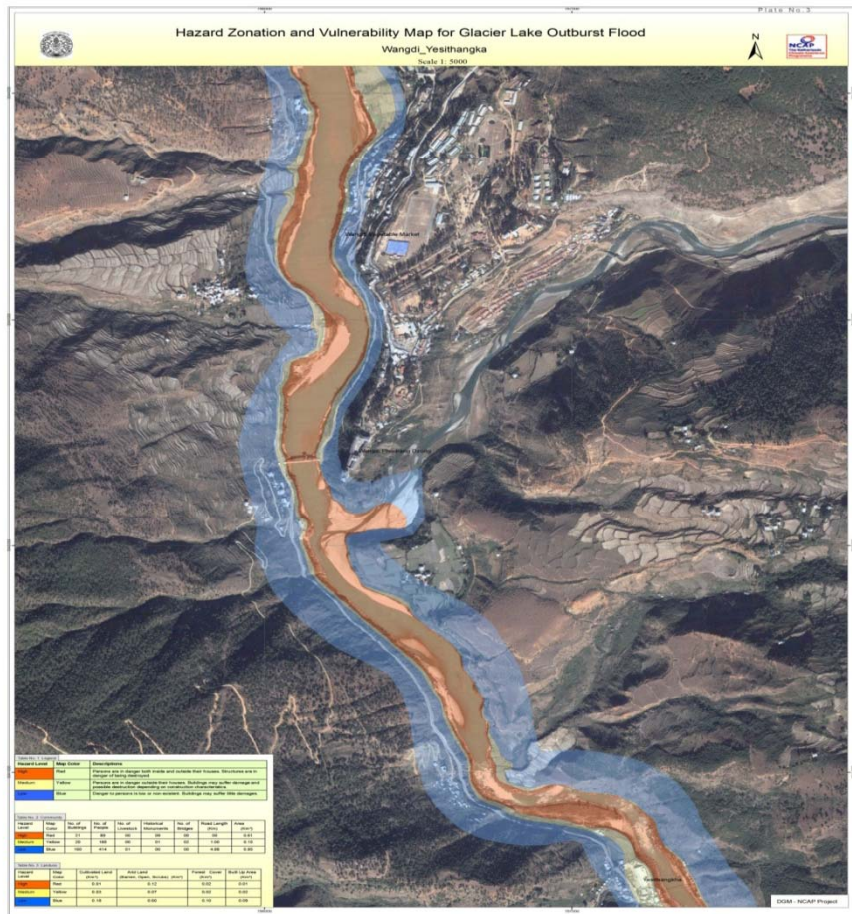


Artificial lowering of Thorthormi Lake: Department of Geology and Mines

GLOF Hazard Zonation & Vulnerability assessment

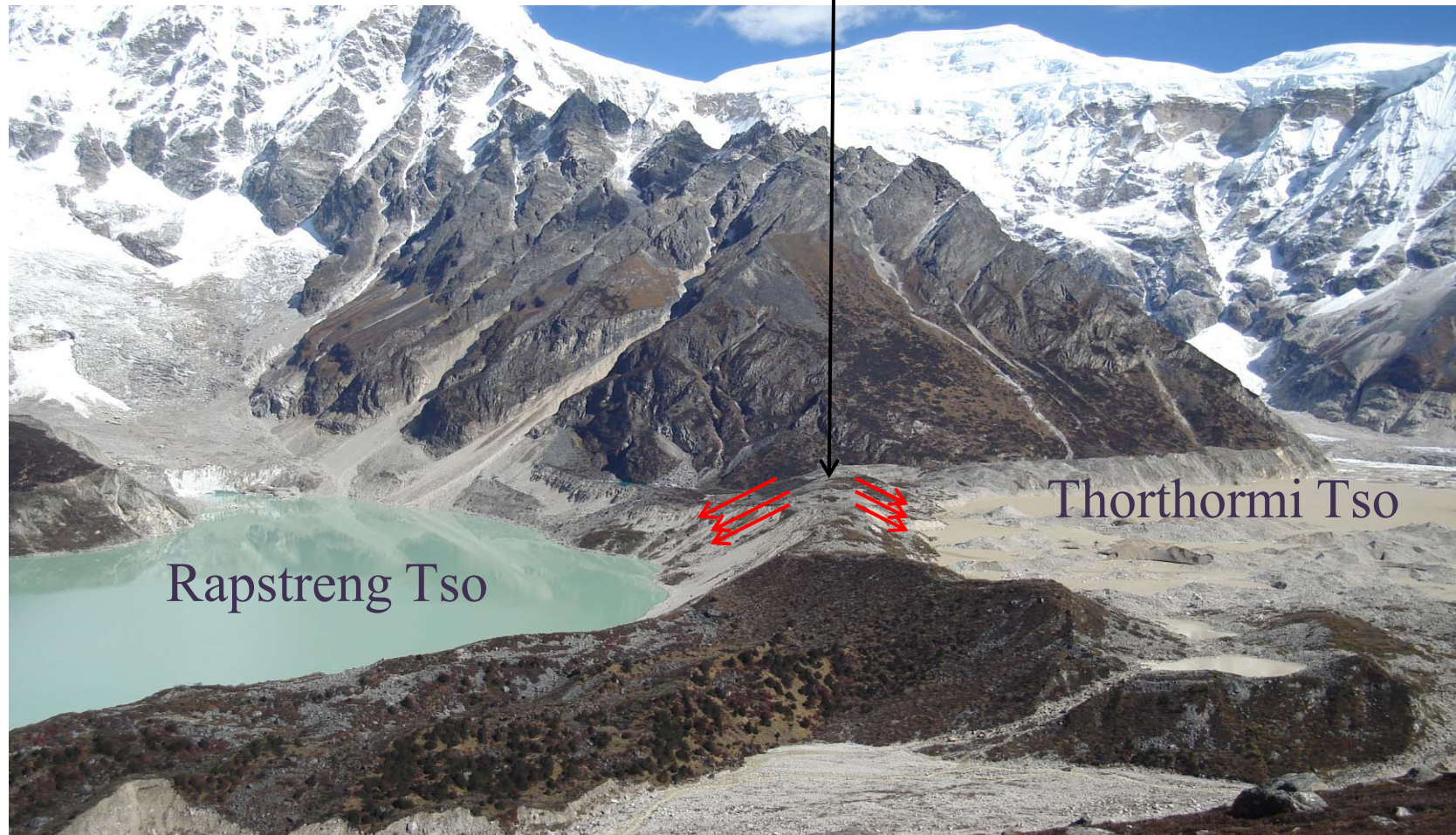
- Lunana to Khuruthang town, Punakha: Austro-Bhutanese (1999-2002)
- Khuruthang-Lhamoizingkha (Indo-Bhutan Border): DGM under Netherlands Climate Assistance Program (NCAP, 2007)
- Chamkhar valley, Bumthang: DGM in 2007 funded by the Global Environment Facility (GEF)

GLOF Hazard Maps (Punakha-Wangdue & Chamkhar)



Hazard & Risk Mitigation works

Moraine Barrier



Results in the thinning of the moraine barrier between Rapstreng and Thorthormi Tso

Raphstreng Tsho (Lake) Mitigation (1996-1998)

- Based on assessment after 1994 Lugge Tso outburst, Raphstreng Tso found to be critically dangerous
- Work started in 1996 to lower the water level by 4m
- Funded by the Royal Government of Bhutan & Government of India
- Coordinated by the Ministry of Home & Cultural Affairs

Raphstreng Tsho (Lake) Mitigation (1996-1998)



Fig. 4. 1 (a)
DISAPATED BY
OFF BY CANY BASKETS



Fig. 4. 1 (b)
WIDENING BETWEEN SUBSIDIARY LAKE I & II
(WORK IN PROGRESS)

Thorthormi Tsho (Lake) risk mitigation (2008-2012)

- Design for 4 years with 4 months of working duration each year
- 360 workers
- USD 4.23 million +RGOB Co-financing
- Objective : lowering lake level by 5m in Thorthormi Tso (Approx. to 17 million cubic meters)
- Successfully lowered the lake level by 5m
- Reduced GLOF risk from the lake
- Minimal impact to the environment
- Benefits in terms of income generation to the communities

Thorthormi Tsho (Lake) risk mitigation (2008-2012)



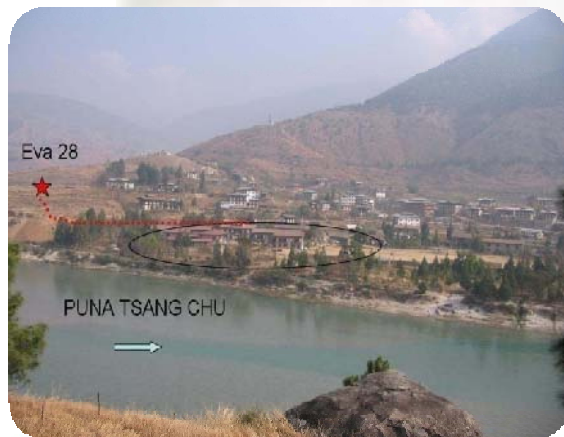
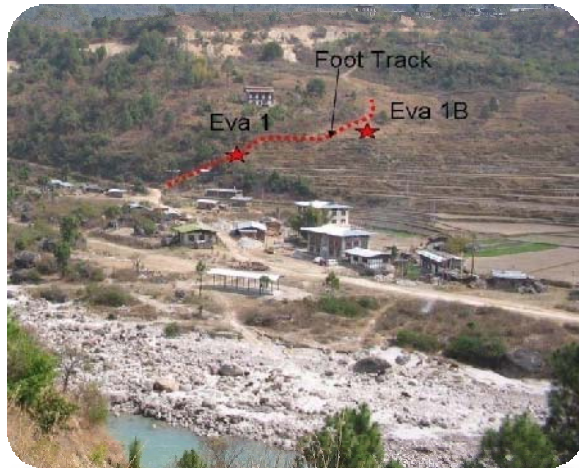
Early Warning System for GLOF

- Under the GLOF project a comprehensive EWS installed in the Pho Chhu and Punatsang Chhu valleys to provide sufficient lead time for evacuation
- Community awareness EWS through mock drill
- Sites identified along the valley for emergency evacuation

Early Warning System for GLOF

- Under the GLOF project a comprehensive EWS installed in the Pho Chhu and Punatsang Chhu valleys to provide sufficient lead time for evacuation
- 31 Vulnerable communities identified
- Public consultation meeting for Information sharing on GLoF event
- Community Focal Points for Early Warning in each vulnerable area
- Community Focal Points issued with Mobile phones/sim card /monthly vouchers
- ToR developed for Community Focal Points
- Information Flow mechanisms arranged

Early Warning System for GLOF



Mock drill for evacuation during GLOF

- Mock drill in each vulnerable communities by activating the automatic EWS;
- To ensure fast, organized and smooth evacuation during emergencies
- To test the working conditions and effectiveness of GLoF Early Warning System
- To familiarize with evacuation sites/route

Conclusions

- Timely interventions have definitely enhanced GLOF disaster resilience in the Punakha-Wangdue and downstream communities from GLOF hazard
- Through the mitigation process at the source, hazard cannot be totally eliminated , therefore EWS and community awareness is a vital component of the project towards holistic disaster risk reduction

Why Awareness - Flood Scare!!!



Waiting to be washed away



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Thank You

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