Science Seminar on:

Climate Change-induced Risks and Vulnerabilities of Glacial Lake Outburst Floods (GLOFs).



Science Seminar on Climate Change-induced Risks and Vulnerabilities of Glacial Lake Outburst Floods (GLOF)





26 to 27, November 2019

Punatshangchhu Cottages, Wangduephodrang

Organized by ational Center for Hydrology and Meteorology (NCHM) in collaboration with the Department of Local Government, MoHCA funded by UNDP



Executive Summary

The first ever science seminar titled "Climate change-induced risks and vulnerabilities of Glacial Lake Outburst Floods" was held from 26-27th November, 2019 at Punatsang Chhu Cottages, Wangdue Phodrang. The event was organized by National Center for Hydrology and Meteorology (NCHM) in collaboration with Department of Local Government, Ministry of Home and Cultural Affairs (MoHCA) under the financial support of UNDP. The Seminar included sensitization and transfer of knowledge concerning the Glaciers and Glacial Lakes located at the head waters of Punatsang Chhu river and the danger it poses to the community and development located downstream. The seminar involved close to 70 participants including local government officials, civil servants, project officials, defense, law enforcement, media, policy makers and provided an opportunity for the participants to be informed about the status of glaciers and its associated risks. The key messages of the seminar included the following: that the seminar was apt considering the time and place; collaboration with Department of local government being very important; and finally, involving the local government officials crucial in making the public aware of the risks of GLOF.



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1 Introduction

It is evident and has been accepted internationally that glaciers all around the world are thinning and retreating due to global warming. The quantity of glaciers melting is very alarming since glacier melt water forms lakes and could easily outburst in the form of Glacier Lake Outburst Floods (GLOFs). Climate change has accelerated the shrinkage of glaciers and glacier lakes are increasing and forming quickly making them more hazardous.

Settlements in the Himalayan region are mostly situated near to the river bank or within the high flood plain. GLOF events have huge impacts in the downstream [area] causing loss of lives and livelihood, damage to the settlements, roads, bridges, and most importantly hydropower projects which is the major contribution to the economy. With consensus by the experts both locally and internationally on the imminent threat the GLOF poses, Bhutan has started taking measures so that it has minimum impact if GLOF event happens. However, drastic measures cannot be undertaken considering the economy of the country.

2 Proceedings

The first of the two days was Technical session involving Knowledge sharing/Sensitization and the next day was engaged in familiarizing the participants through a site visit regarding the setup of GLOF Infrastructures.



Day 1: Inaugural Session

The inaugural session of the seminar involved the traditional marching ceremony on the first day, which was graced by chairperson of National Council as Chief Guest, Deputy Resident Representative of United Nations, Wangdue and Gasa Dzongda, representative from Royal Bhutan Army and Royal Bhutan Police, Director of Department of Local Government, local leaders and other officials from different agencies.

The ceremony was followed by welcome remarks by the Director, NCHM. The Director stressed that climate change being unequivocal phenomenon, the world would bear huge brunt. The Chief Guest, gave the keynote speech highlighting the importance of the seminar considering its timing and place of the meeting in light of climate change and its impact. He also emphasized that such seminar would help in sensitizing the local government and line agencies regarding climate scenarios globally and in Bhutan and the likely effect it will have on Bhutan. Following the speech, a short audio-visual clip of NCHM was presented to the participants before the group photo and poster presentation outside.

Day 1: Technical Session

The technical session involved presentation from different officials on different issues and after each presentation there was a brief question and discussion session.

Session II: Climate Change Science and findings.

Chair: Dasho Dzongda, Gasa Dzongkhag Administration Co-Chair: Karma G Chhophel, Chief Environment Officer, PHPA- I Presenter: Mr. Phuntsho Namgyal, Chief Engineer, NCHM; Mr. Tshencho Dorji, Exe. Engineer, NCHM Mr. Phuntsho Namgyal, the first presenter, shared the information on IPCC reports and its key messages. The first report "climate change and land" highlighted that there is following impact depending on the global temperature level: High risk: significant and widespread impacts / risks – close to 1.5; periodic food shocks across regions: Around 1.5; very high chance of severe impacts / risks, irreversibility or persistence- above 1.5 °C.

The second report "the ocean and cryosphere in changing climate" highlighted the three key messages; oceans getting more warm, acidic, Glaciers retreating, sea level rise accelerating; centennial sea events to occur annually by 2050 and finally huge cost implication on coastal adaptation measures.

The third report "Global warming of 1.5^o" highlighted the three key messages; already experiencing negative impacts at 1.5^oc; deep emissions reduction needed in all sectors and finally current NDC being not sufficient and that next 10 year to be a critical decade.

The second presentation was presented by Mr. Tshencho Dorji on "ANALYSIS OF HISTORICAL CLIMATE AND CLIMATE PROJECTION FOR BHUTAN". In his presentation he talked about the global scenario of climate change and he explained that the national temperature trend shows similar changes to the global temperature trend which is increasing every year. The future climate change projection shows that under the RCP4.5 an increase of about 0.8°C-2.8°C is expected during 2021-2100 and under the RCP8.5 an increase of about 0.8°C-2.0°C is expected during 2021-2050 and increase of about 3.2°C towards the end of the century (2070-2100).

Under the RCP 4.5 the rainfall over Bhutan indicates an increase of about 10%-30% on the mean annual scale, with increase in summer (JJAS) rainfalls between 5%-15%.

Under the RCP 8.5 the mean annual rainfall indicates an increase of about 10%-20% during 2021-2050 and with more than 30% increase over Bhutan towards the end of the century (2070-2100)

Session III: Climate Change and GLOF Risk Reduction Activities

Chair: Dasho Dzongda, Wangdue Phodrang Dzongkhag Administration
 Co-Chair: Director, NCHM
 Presenter: Mr. Wangchuk Namgyal, Geologist, NCHM
 Mr. Tshering Tashi, Sr. Hydrology/Meteorology Officer, NCHM
 Mr. Phuntsho Tshering, Sr. Geologist, NCHM

The first presentation was presented by Mr. Wangchuk Namgyal on "Bhutan Glacier Inventory 2018". In his presentation he mentioned about the first glacier inventory in Bhutan. He explained the methodology used for glacier inventory and the data used in the glacier mapping.

The second presentation was presented by Mr. Tshering Tashi on" Potentially dangerous glacier lakes". In his presentation he mentioned about the numbers of lakes that are dangerous in Bhutan and the numbers of the dangerous lakes has been reduced from 25 to 17, were the potentially dangerous lakes are more situated in Pho chu (9 lakes).

The third presentation was presented by Mr. Phuntsho Tshering on "Over view on recent GLOF events". In his presentation he explained about the past GLOF events and he also presented the recent GLOF event in Thorthormi Subsidiary Lake GLOF that took place on 20th June 2019.

Session IV: GLOF Monitoring, Preparedness and Early Warning System and Climate Change adaptation

Chair: Director, DLG Co-Chair: Dr. Singye Dorji, Chief, WCSD, NCHM Presenter: Mr. Sangay Tenzin, Assistant Engineer, HWRSD

The presentation was made by Mr. Sangay Tenzin on "GLOF/ Rainstorm Early Warning Station (EWS)". In his presentation he explained the difference between GLOF and Rainstorm and also about the "ALERT" and "ALARM" levels. He also showed and explained about the main components of early warning stations and communication of GLOF EWS.

Day 2: Field Visit

The field trip was held on the second day of the seminar where all the participants from different agencies visited the Wangdue GLOF EWS control room. The In-charge Mr. Purna explained all about the works they carry out in control room, how they study and monitor the GLOF situation and dessimenate alert/warnings to relevant stakeholder. His presentation also touched on SOP on GLOF events, siren warnings, and communication during emergencies. The participants took equal interest in knowing how the GLOF early warning system worked.

3 Conclusion

The two days program ended successfully with the participants having become aware of the global and national implication of climate change and the works NCHM is doing with regards to GLOF, flood risks mitigation, water resources and climate information generation in the light of changing climate. The GLOF early warning system and studies done on glaciers and glacial lakes were also received were well by the participants owing to its relevance to the local government leaders. The local government officials were fundamental in making the seminar a success since the motive behind was to inform the works that NCHM is doing to the public especially to sensitize them on GLOF early warning system and information generation works that are being carried out as part of adaptation measures to climate change. Finally, the seminar has been very effective in providing information to the local government leaders in following areas:

- Current climate change related findings from IPCC special reports;
- Historical Analysis and Climate change projections of Bhutan;
- States of glacier and glacier lakes in Bhutan, especially in the headwaters of Punatsang Chhu basins
- Hazards and risks associated with glacier lake outburst flood;
- GLOF mitigation and GLOF EWS for climate change adaptation;

- Inform the public and related stakeholders on the operational procedure of the GLOF early warning system in Punatsang Chhu basin.

In addition, the following were the key takeaways from the two days seminar – i. Chief Guest recognized the importance of the seminar and relevance to local government leaders in Puna-Wangdue Valley; ii. The requirement of sensitization workshops on GLOF EWS and associated risks, and NCHM's services to public; iii. Involving local government officials through Department of Local Government is required for effectiveness of such seminar.

In addition we have enclosed: Annexure I – Concept note and Program Agenda Annexure II – List of participants

Annexure I: Concept Note and Program Agenda



Science Seminar on

Climate Change-induced Risks and Vulnerabilities of Glacial Lake Outburst Floods (GLOF) (26 to 27 November 2019)

Organized by National Center for Hydrology and Meteorology (NCHM) in collaboration with Department of Local Government, MoHCA funded by UNDP

(Venue: Punatshangchhu Cottages, Wangdue Phodrang)

1 Background

Climate change is unequivocal, according to the latest Intergovernmental Panel on Climate Change (IPCC) reports. IPCC Special Report on Global Warming of 1.5 °C warns that the impact could be much higher than expected in the higher altitude regions. A mountainous country like Bhutan is highly vulnerable. Climate change impacts are already being felt in the country. Hydro-Meteorological hazards such as floods have become more frequent due to rainfall and untimely monsoon. Windstorms have become more severe and frequent. Shortage of both drinking and irrigation water has become a national issue. Certain places have started experiencing long dry periods and abnormally high temperatures in others.

The most significant impact of climate change in Bhutan is the formation of supra-glacier lakes due to the accelerated retreat and melting of glaciers with increasing temperature. Glaciers in Bhutan are receding at a rate of 30 - 35 m per year for the debris covered glaciers and 9 - 12 m for the clean type glaciers (Japan-Bhutan joint report, 1999, 2003). The melting of ice from these receding glaciers are increasing the volume of water in glacier lakes, melting of ice core within the moraine dams surrounding these lakes leads to destabilization of damming materials pushing the hazard of Glacier Lake Outburst floods (GLOFs) to a critical level. The risk of potential disaster in fact by GLOF, pose new threats to lives, livelihood and development in the downstream. Bhutan has more than 700 glaciers (Bhutan Glacier Inventory, NCHM, 2018) and 2674 glacier lakes (ICIMOD & DOM, 2001) in the major head waters of Bhutan. As per the revised Assessment of Potentially Dangerous Glacier Lakes (PDGL) in Bhutan 2018 (NCHM, 2018), 17 lakes have been identified as potentially dangerous lakes. Out of the 17, 11 PDGLs are located within the Punatsang Chhu basin i.e., 9 in the Pho Chhu head water and remaining 2 in Mo Chhu sub-basin. All the four lakes in Lunana - Lugge, Thorthormi, Rapstreng and Drukchung falls under the PDGLs of Bhutan. Due to the high risks of GLOF in this basin, the Government through the National Adaptation Programme of Action (NAPA-I) project implemented the Thorthomri Lake mitigation work and Installed Glacier Lake Outburst Flood (GLOF) Early Warning System (EWS) along the Punatsang Chhu basin (2008-2013) and under the JICA support in the Mangde Chhu and Chamkhar Chhu basin (2013-2016) to reduce the risks and timely dissemination of GLOF information downstream, in the event of a GLOF. Most recent GLOF events after 1994 GLOF from Luggey Tsho on Pho Chhu in Bhutan is from Lemthang Tsho outburst from the head water of Mo Chhu on 28 June 2015 and Thorthormi lake subsidiary Lake II outburst on 20 June 2019.

The recent incident from Thorthomii lake in Lunana in the month of June 2019 had created panic among I • the communities who are settled along Pho Chu river. On analyzing the temperature data from Thanza automatic weather station in Lunana, it was found that the month of April, May and June 2019 recorded the highest monthly average temperature compared to the last eight years.

The National Center for Hydrology and Meteorology (NCHM) as the scientific and technical autonomous agency in Bhutan is mandated to provide scientific and technical services in hydrology, water resources, meteorology, climatology, and cryosphere to ensure the safety, socio-economic well-being of society. The Center has carried out studies ~n climate parameters such as temperature and precipitation along different

physiographic zones in the country, historical climate analysis and climate projection for Bhutan, updated glacier and potentially dangerous glacial lake inventory in the country. The Center also established long term glacier mass balance stations on two bench marked glaciers (Thanza and Gangju la glaciers) for understanding of glaciers behaviors in Bhutan.

Considering the importance of such information for the public, NCHM is proposing for one and half day scientific workshop on the theme "Climate Change-induced Risks and Vulnerabilities of Glacial Lake Outburst Floods (GLOF)".

2 **Objectives**

The objectives of the seminar are to;

- A. Share knowledge and experiences with the Local Governments and other stakeholders in the following:
 - Current climate change related findings from IPCC special reports;
 - Historical Analysis and Climate change projections of Bhutan;
 - States of glacier and glacier lakes in Bhutan, especially in the headwaters of Punatsang Chhu basins
 - Hazards and risks associated with glacier lake outburst flood;
 - GLOF mitigation and GLOF EWS for climate change adaptation;
 - Inform the public and related stakeholders on the operational procedure of the GLOF early warning system in Punatsang Chhu basin.
- B. Sensitize Local Governments and other stakeholders about the GLOF hazards and its impacts, and
- C. Share regional and international experiences and best practices on GLOF by UNDP

3 Proposed Venue and Time

In line with the decentralization process of the 12th FYP and to enhance the education and awareness of local government officials and vulnerable communities, it is proposed that the seminar be held in GLOF vulnerable areas Wangdue Phodrang valley on 26-27 November, 2019. This is to facilitate participation by officials of local government and relevant stakeholders who are engaged in Disaster Management at local government and community level. On the second day the participants will also be taken to the GLOF EWS facilities installed along the Punakha Wangdue Valley under NAPA-II Project.

4 Expected Participants

The seminar will provide a forum to share knowledge and information on the current scenarios of climate globally and within the country to the civil servants, local government officials, armed forces, media and civil society. While the experts from the Center present and discuss the scientific Knowledge and status of climate, the media, local government, line agencies will be sensitized and better informed to gauge their preparedness in adapting to associated risks and to disseminate the information to general public. The

expected number of participants is close to 50. An additional 16 officials from NCHM will also participate and will form a core group.

5 Program Agenda

Inaugural Session

Day I: 26 November 2019

08.30-09.00	Arrival of Guests and Participants	
09:00- 11:30	Session I: Opening Session	
09.15-09.25	Arrival of Chief Guest	
09.25-09:35	Traditional "Marchang" ceremony	Director, NCHM
09:35-09:45	Welcome Remarks including objectives of the seminar	Director, NCHM
09:45- 09:55	Welcome Remarks	Director, DLG, MoHCA
		Mr. Juergen Nagler
09:55- 10:05	Welcome Remarks	Dy. Resident Representative
		UN Development Program, Bhutan
10:05- 10:15	Keynote address by the Chief Guest	Hon'ble Chairperson of the National Council of Bhutan
10:15- 10:30	NCHM Audio-visual/documentary	MC, NCHM to coordinate
10:30-10:40	Vote of thanks	Phuntsho Namgyal, Seminar Coordinator
10:40- 10:50	Group photo	MC: NCHM to coordinate
10:50 – 11:30	Tea/coffee break	Poster and Exhibition Session

Master of Ceremony (MC):Ms. Sonam Choki, NCHMMarching Assistant:Mr. Phurpa Wangdi, NCHM

Technical Sessions

Day I: 26 November 2019 (Morning)

11.30-Session II: Climate Change Scie12:40findings	Chair: Dasho Dzongdag, Gasa Dzongkhag Administration Co-Chair: Karma G Chhophel, Chief Environment Officer, PHPA- I
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11.30- 11.50	Presentation on climate change science – Findings from recent IPCC Special reports	Phuntsho Namgyal, NCHM
11.50- 12:10	Analysis of historical climate and climate change projection	Tshencho Dorji, WCSD, NCHM
12.10 - 12.40	Questions and Discussions	Discussion will be moderated by the Chair
12.40- 13.40	Lunch break	

Day I: 26 November 2019 (Afternoon)

13.40- 17:00	Session III: Climate Change and GLOF Risk Reduction Activities	Chair: Dasho Dzongdag, Wangduephodrang Dzongkhag Administration Co-Chair: Director, NCHM
13.40- 14.00	Bhutan Glacier Inventory 2018 and field-based works on glaciers	Wangchuk Namgay, NCHM
14.00- 14.20	Re-assessment of potentially dangerous glacier lakes	Tshering Tashi, NCHM
14.20- 14.40	 Recent GLOFs - Overview of Thorthormi subsidiary lake II breach on June 20, 2019 and Lemthang Tsho breach of 2015 and 1994 GLOF and GLOF from Tshojo 2019 Lessons from rapid rehabilitation of essential public early warning system carried out in June 2019 	Phuntsho Tshering, CSD, NCHM
14.40- 15.10	Questions and Discussions	Discussion will be moderated by the Chair
15.10- 15.40	Tea/Coffee Break with Poster and Exhibition Session	

15.40- 17.00	Session IV: - GLOF Monitoring, Preparedness and Early Warning System and Climate Change adaptation	Chair: Director, DLG Co-Chair: Dr. Singay Dorji, Chief, WCSD, NCHM
15.40- 16.00	GLOF Monitoring and Early Warning System in and Hazard Mapping: Preparedness for Eventuality	Sangay Tenzin, HWRSD, NCHM
16.00- 16.20	Climate Change Adaptation and Mitigation in Bhutan	NECS
	Session V: Closing	
16.20 – 16.30	Closing remarks	Director, NCHM

16.30- 17.00	Vote of thanks from participants	
19:00	Closing Dinner and Screening of documentary - Himalayan Meltdown	

Field Trip

Day II: 27 November 2019 (Morning)

09.15- 13:00	Session VI: Field Trip	NCHM to coordinate
09:15- 11.30	Field Trip	Visit to GLOF EWS Control Room at Wangdue NCHM to facilitate.
12.00 - 13.00	Lunch (back at the hotel)	

Annexure II: List of Participants

SL	NAME	DESGINATION	AGENCY
1	Sonam Jamtsho	Dasho Dzongda	Wangdue Phodrang Dzongkhag Administration
2	Rinzin Penjore	Dasho Dzongda	Gasa Dzongkhag Administration
3	Juergen Nagler	Deputy Resident Representative	UNDP
4	Kado Zangpo	Director	Department of Local Government
5	Krisha Subba	DCFO	JICA
7	Col. Karma Sonam	S.P, Wangdue	Royal Bhutan Police
8	Lt. Col. Sonam Wangchuk	Commandant, Tencholing Training Center	Royal Bhutan Army
9	Major Singye	0.C	Royal Bhutan Police
10	Lt. Jigme T	0.C	Royal Bhutan Police
11	Thinley dorji	Jt. Managing Director	PHPA-I
12	G.K Chhopel	Chief Environment Officer	PHPA-I
13	Wangchuk	CSFO	PHPA-I
14	Lhatu Dorji	Sr. Fire Officer	PHPA-I
15	Kezang Yangdon	Program Director	WWF
16	Chogyel Wangmo	Lecturer	CNR
17	Yogata Dahal	Lecturer	CNR
18	Sonam Wangdi	НОР	BHP-DGPC
19	Ugyen Wangdi	Sr. Environmental Officer	PHPA-I
20	Sangay Dolma	Environmental Officer	PHPA-I
21	Kinley Namgay	CSO	PHPA-II
22	Norbu Tshering	Sr. Fire Officer	PHPA-II
23	Dechen dorji	Executive Engineer(Electrical)	DGPC, BHP
24	Ashim chettri	Assistant Engineer(Civil)	DGPC, BHP
25	Namgay Tenzin	Sr. Program Officer	WFF
26	Sangay Dorji	Program Officer	DLG, MoHCA
27	Chimi Dema	Assistant Program Officer	GNHC
28	Tashi Dhendup	Environment Officer	NECS
29	Tshering Wangchuk	Program Officer	DDM, MoHCA
28	Tashi Dhendup	DPO	Gasa Dzongkhag
30	Deki Yangzom	DDMO	Gasa Dzongkhag
31	Choki Wangchuk	ADHO	Gasa Dzongkhag
32	Ngwang Namgyel	Driver	Gasa Dzongkhag
33	Lobzang Cheda	GHO	Punakha Dzongkhag
34	Phub Tshering	Environment Officer	Punakha Dzongkhag
35	Tshewang Phuntsho	Disaster Focal	Punakha Dzongkhag
36	Sonam Tobgay	Gup	Chhubu Gewog, Punakha
37	Jimba Gyeltshen	Mangmi	Chhubu Gewog, Punakha
38	Chencho Dorii	Mangmi	Rubesa, Wangdue Phodrang
39	Tshering Tobgay	Mangmi ,	Toewang Gewog, Punakha
40	Kado	Tshokpa	Toewang Gewog, Punakha
41	Tshechu	Gup	Dzomi Gewog, Punakha

42	Sherub Dorji	GAO	Dzomi Gewog, Punakha
43	Yangchen Dema	Tshogpa	Dzomi Gewog, Punakha
44	Dawa Tashi	Mangmi	Dzomi Gewog, Punakha
45	Passang Namgay	Driver	Dzomi Gewog, Punakha
46	Jigme Dorji	Planning Officer	W/Phodrang Dzongkhag
47	Sangay Norbu	Environmental Officer	W/Phodrang Dzongkhag
48	Sarita Gurung	GAO	Thedtsho Gewog,Wangdue
49	Choki Wangmo	Reporter	Kuensel
50	Karma Dupchu	Director	NCHM
51	Tayba B.Tamang	Chief	NCHM
52	Phuntsho Namgyal	Chief	NCHM
53	Singye Dorji	Chief	NCHM
54	Ragham	TMO, Gol	NCHM
55	Phuntsho Tshering	Sr. Geologist	NCHM
56	Tshencho Dorji	Dy. Ex. Engineer	NCHM
57	Tshering Tashi	Sr, Hydro-Met Officer	NCHM
58	Sonam Choki	Hydro-Met Officer	NCHM
59	Chimi Namgyel	Statistical Officer	NCHM
60	Yeshi Choki	Hydrology Officer	NCHM
61	Monju Subba	Engineer	NCHM
62	Pema Wangdi	Engineer	NCHM
63	Wangchuk Namgay	Geologist	NCHM
64	Sangay Tenzin	Engineer	NCHM
65	Bikash Pradhan	Engineer	NCHM
66	Sonam Tashi	Weather Forecaster	NCHM
67	Sangay Dorji	Program Officer	Department of Local Government
68	Purna	In-charge	Wandue Control Room, NCHM
69	Phurpa Wangdi	Hydro-Met Technician	NCHM
70	Ugyen Dolma	Technician	NCHM
71	Sonam Tshewang	Driver	NCHM
72	Sonam Dorji	Driver	NCHM
73	H.B Subba	Driver	NCHM