Site Assessment Report of Dechencholing Flash Flood Incident
10 August 2024, Thimphu

Submitted by Technical Team
National Centre for Hydrology and Meteorology (NCHM),
Department of Geology and Mines (DGM),
Ministry of Energy and Natural Resources (MoENR)
14 August 2024

1. Introduction

The Ministry of Energy and Natural (MoENR) constituted a technical team from the National Center for Hydrology and Meteorology (NCHM) and Department of Geology and Mines (DGM) for field assessment to determine the cause of Dechencholing flash flood incident occurred on 10 August 2024 afternoon. The technical team visited upstream catchment areas on 13th August 2024 accompanied by a representative from the Kawang Gewog, Thimphu Dzongkhag. Team submitted preliminary findings to the Secretary, MoENR on the evening of 13th August.

The following are the Technical Team members who conducted the site assessment.

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2. Mr. Tandin Wangchuk, Dy. Chief Hydromet Officer, NCHM.
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7. Mr. Sonam Dorji, Hydromet Technician, NCHM

1.1 Location

The Dechencholing settlement lies in the north Thimphu region with a catchment area of Dechencholing chhu is approximately 17 sq. km. There are numerous tributaries from both the sides contributing to the flow of mainstream. Two major streams (marked 1 & 2) in the map (Figure 1) are the main source and forms Dechencholing Chhu.

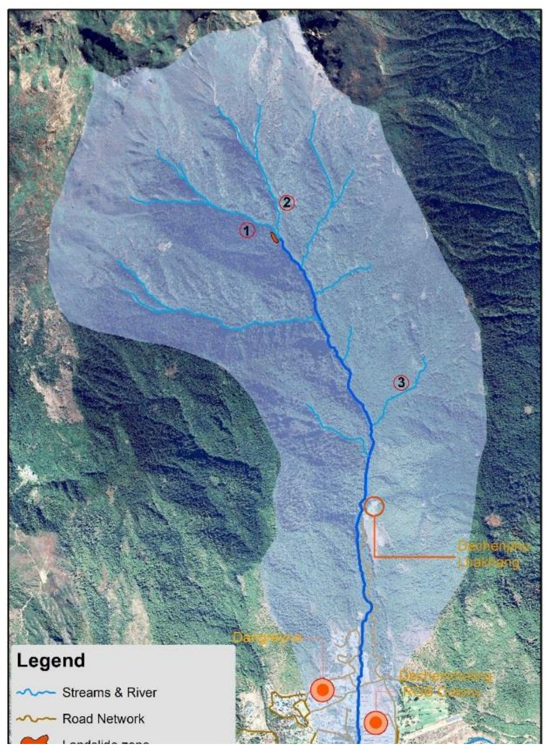

Figure 1: The catchment area of the Dechenphu Chhu, showing major tributaries and streams.

2. Observation

2.1 Local Geology

Geologically, the Dechencholing area is part of what is known as the Thimphu Formation primarily consisting of amphibolite-facies metasedimentary rocks, including quartzite, gneiss, and schist. Along the Dechenphu Chhu section, especially around the Dechenphu Lhakhang area, medium-grained, silverish, moderately weathered two-mica schist with quartz boudinage was observed. Some small wrappings were also noted on these exposures. Upstream of Dechenphu Chhu, medium to coarse-grained, light gray gneiss, ranging from competent to slightly weathered, with medium-grained quartzite interbeds, was observed.

Characteristic of the higher reaches of the Greater Himalayan region, the topography and geomorphology of the area is defined by steep gradient leading to high velocity river flow. The steep slopes of the valley result in significant erosion with the river carving deep valleys and gorges. This process leads to formation of V-shaped valleys and canyons. Due to high energy, these rivers can transport huge boulders and coarse materials which are deposited in flatter areas downstream.

2.2 Slope instability

The flash flood triggered several landslides along the stream. These landslides are approximately 5 to 6 meters high, consisting mainly of light brown, sandy soil with a gritty texture and small mica flakes. The soil's sandy nature might have made it highly susceptible to erosion, leading to landslides. Along the river channel, several incidences of slope instabilities due to erosion of slope base were observed leading to increased turbidity and sediment load in the river. A landslide was observed on the right side of the confluence of the two streams (Figure 2) which likely resulted in formation of temporary blockage. However, the formation must have been for a short period given the steep river gradient and high velocity of the river. It should be emphasized, however, that the landslide is still active and in event of heavy precipitation there is likelihood of these loose materials coming down from the slope and creating temporary blockage.

Figure 2: Picture showing confluence point of the two steams (marked 1 & 2 in Figure 1). The crown of the landslide is also visible. The second picture is immediately below the confluence showing high flood mark and constriction of the outlet indicating temporary blockage and formation of landslide dam lake at this point.

2.3 Flood Discharge

Average lean flow of stream in winter is around 0.134 cubic meters per sector (NCHM, Lean flow measurement, 2007-2020). Discharge of stream on 11 August 2024 at 10:00 AM is estimated around 0.5 cubic meter per second at Dangrina bridge. The average spot lean flow for the stream from past 18 years is 0.15 cubic meter per second. From the drone image and preliminary hydraulic modeling, the peak discharge during the event, including debris, is estimated to be approximately 120 cubic meters per second, a channel cross sectional at Dangrina bridge from the simulated results is shown in Figure 3. The discharge at the upstream is estimated to be higher based on the flood mark and the cross-sectional area. The channel overflow and diversion which occurred below the Dechenphu parking and along the road has substantially reduced the flood volume that reached the Dechencholing area.

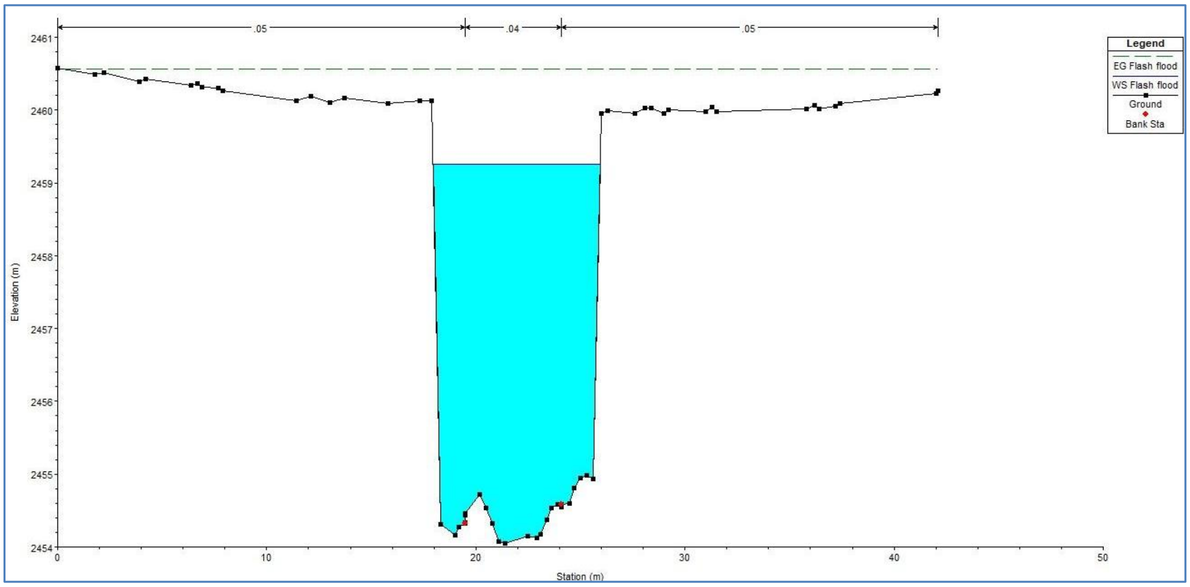

Figure 3: A cross-sectional plot of simulated flood at Dangrina bridge. It was observed during the site visit on 11th August that the flood did not reach the bridge deck and the overflow was from the right side of the bridge.

Based on google and other aerial images, there is no lake upstream of the Dechencholing Chhu. The stream and its tributaries are catchment fed and primarily dependent on rainfall water.

3. Probable Cause of flash flood

Based on the analysis of weather phenomena and satellite images on 10 August 2024, a sudden heavy rainfall with thunder was caused by the Convective Thunderstorm, which usually occurs during this time of the year (summer and spring). From the high-level water marks observed on all the tributaries, antecedent monsoon rainfall and high intensity heavy rainfall on 10 August 2024 has saturated soils and triggered landslides causing the flash flood. As the flash flood moved downstream, the flood further triggered several landslides, notably at the confluence of the two main streams, forming multiple temporary artificial dams along the stream. Based on the turbidity of the water coming from stream marked 1 (Figure 1), it appears flood originated from this stream; the water from stream 2 is clear without any turbidity. It is evident from the field assessment that the flood initially started from stream 1 and the magnitude of the event was exacerbated by multiple landslides that temporarily blocked the flow path as it moved downstream. Out of several tributaries, remnants of flash flood with dislodging of huge boulders and logs with significant flow was observed only in one of the major tributaries marked (3) inthe map. Judging by the topography and morphology, this could likely be attributable to reactivation of old slides by such unprecedented precipitation upstream of this tributary.

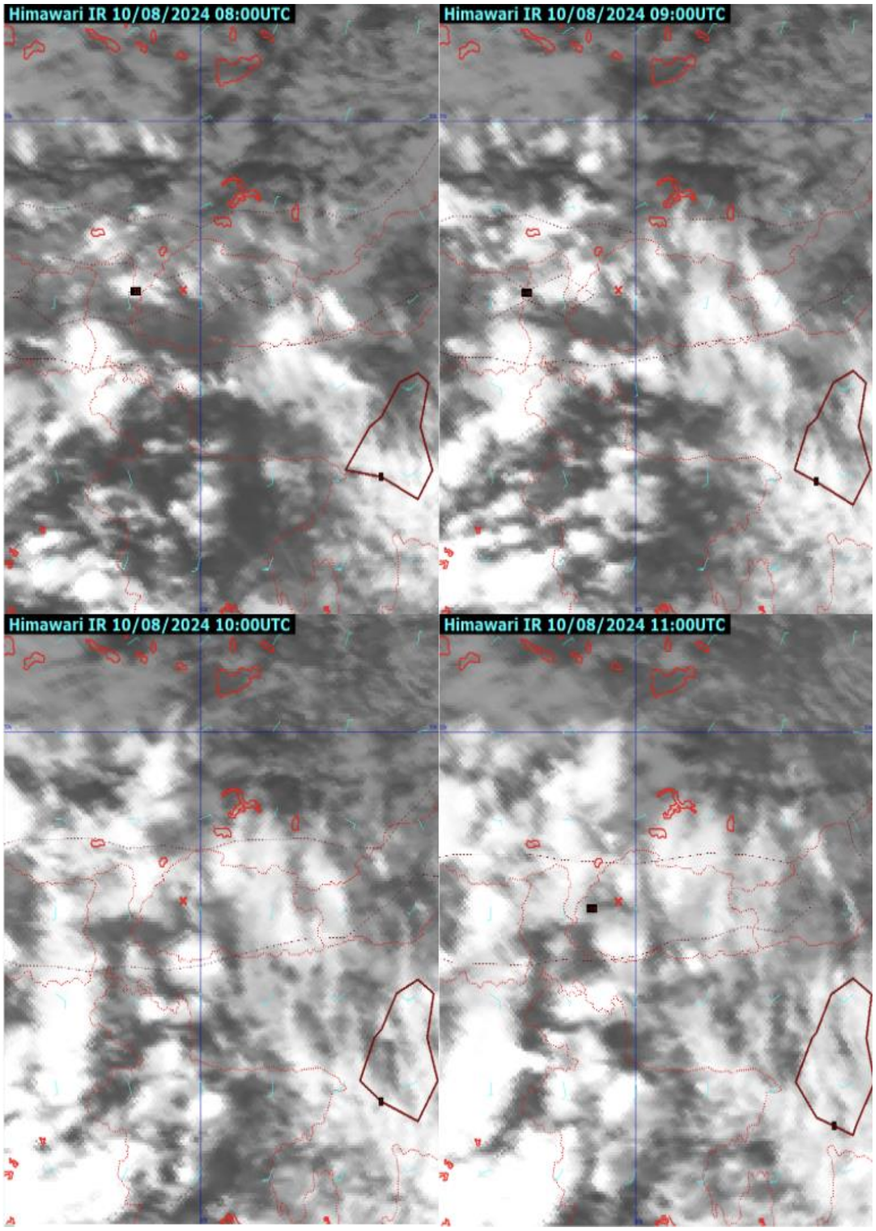

Figure 4: Satellite image analysis (From the Himawari satellite image, a small-scale convective system formed over Thimphu (marked as red cross) can be spotted starting 8 UTC (14:00 BST)

4. Aerial Drone Survey

An aerial survey was carried out on 11 August 2024 in the area affected by the flood (Dechencholing area). The aerial image provides bird eye view of the flood affected area which is essential for the post flood damage assessment and to ascertain probable cause of the flood through image analysis especially in settlement areas. The river channel has adequate conveyance capacity for natural flow but during the flash flood, the debris in the flood water caused overflowing resulting in the widespread debris deposits and damages along and near the river channel. The event was exacerbated at the constricted channel locations such as bridges and underground drainage which clogged the channel and drastically reduced channel flow capacity as shown in Figure. 5.

Figure 5: An aerial drone image showing the affected area

4. Conclusion and Recommendation

1. The loose debris which consists of huge boulders from the active landslide on the right side of the confluence may have created a temporary blockage, resulting in formation of an artificial dam at the stream confluence. Major flooding from tributaries (marked 3, Figure 1) with dislodging of huge debris materials into the mainstream must have created temporary blockage of the river path.

2. Due to non-existence of any hydro-met observatories in the area, the exact amount and duration of the rainfall leading to this unprecedented flash flood in Dechencholing Chhu around 2:30PM with formation of dark clouds over the Dechenphu, followed by heavy rainfall in the area. The heavy rainfall probably persisted for 45-60 minutes.

3. Based on the field observation and other information available to the team, it is very likely the cause of flash flood is due to cloud burst but the magnitude of the flash flood has been exacerbated due to temporary damming formed as a result of landslide and huge debris materials dislodged in the main river from at least one of the tributaries.

4. Since the stream course and bed are disturbed, flash floods may occur during the heavy rainfall. It is suggested to monitor rainfall and water level of the stream (upstream) during the monsoon and recommended to set up a manual Community-Based Early Warning System (CBEWS) to alert and warn vulnerable settlements downstream.

5. Stream channel restoration to pre-flood waterways to minimize the flood water overflow and widespread damage in an event of another flood of similar magnitude or higher.

6. Any structures along the stream should have conveyance capacity of the worst flood event, design discharge needs to be incorporated in bridge constructions and Hume pipe installation to accommodate floodwaters.

7. There is an absolute need to conduct detailed studies, set up mechanisms and establish required instrumentations, as such an unprecedented phenomenon of cloud burst related flash flood disaster is only going to increase due to changing weather patterns. Quaternary geological and geomorphological mapping of the Thimphu valley show tell-tale signs of destructive debris flows having occurred (perhaps repeatedly) in the historical past. Therefore, these streams have the

potential of generating even more destructive flash floods than the one witnessed in the Dechocholing area.

4. Limitations

1. The preliminary assessment was conducted over just one day, so all findings are based on observations from a single-day survey. This may not fully represent the area's conditions or variations.
2. Access to the upstream area of Dechenphu Chhu was limited due to the steep slope, which made it difficult to proceed further.
3. No access to Satellite image of event and no hydro-met stations in the area to ascertain the exact amount of rainfall and other important parameters.
