

Response of Flash Flood Hazards to Climate Change in Mangkolemba, Nagaland

Latonglila Pongen*¹ and M.S Rawat¹

¹Department of Geography, Nagaland University Lumami

Abstract: Nagaland is vulnerable to various natural disasters, including landslides caused by geological hazards, flash floods caused by hydrological hazards, and drought and forest fires caused by climate change. Since late July 2018, hundreds of residents in the Indian state of Nagaland have been cut off due to floods and landslides that have blocked or destroyed roads, leaving them without access for weeks. Mokokchung district is mountainous and surrounded by multiple drainage systems. The study area has experienced an intensification of disastrous events due to the extreme escalation of anthropogenic activities, including unplanned settlement growth, infrastructure development, mining, and expansion over hazardous zones in narrow valleys. On August 10, 2022, many places in and around Mangkolemba, Mokokchung district, experienced flash floods and landslides due to continuous, intense rain. The town has been completely cut off as a result of the disaster. Twelve houses in the Hokiyong ward sustained damage from landslides. Additionally, it has been claimed that numerous road blockages are connecting Mangkolemba town to the neighboring villages, as well as that the road between Khar village and Mangkolemba has been blocked by debris and boulders. The current study is focused on addressing the hydro-meteorological threats that have recently arisen in the Mokokchung district's Mangkolemba sub-division, paying particular attention to the detailed investigations carried out in the afflicted area.

Keywords: Hydrological hazards, floods and landslides, Mangkolemba, Mokokchung

Introduction: Flash floods are generally the outcome of the interaction between meteorological factors and topography or surface characteristics of the drainage basin in terms of geomorphology (Costa, 1987; Youssef *et al.*, 2009; Kharraz *et al.*, 2012; Karmokar and De, 2020). Flash floods are associated with short, high-intensity rainstorms (Penna, Borga, Zoccatelli, and Marston, 2013) and can be accompanied by other hazards, such as landslides and mudslides (Collier, 2007). As geomorphological phenomena, flash floods are short-lived events brought on by a rapid increase in a river's or stream's discharge. Through erosion and sedimentation, they can have significant geomorphic effects (Reid, 2014). It may occur within six hours of notable precipitation events and is caused by intense storms that induce heavy rainfall in a brief amount of time. Inundation over dry areas occurs within minutes to a few hours following rainfall events, potentially leading to devastating impacts on both people and infrastructure (Hong *et al.*, 2012).

Flash floods are considered to be one of the most devastating natural disasters globally, as they can result in extensive damage, economic loss, and fatalities. The frequency of flash flooding is increasing in many regions due to the growing social and economic pressures on land use. Flash floods' swift and deadly nature is mainly attributable to the unique characteristics of these events, which occur over small spatial scales and have short time frames. (e.g., Intense precipitation or precipitation over highly saturated soils in mountainous terrain) (Georgakakos & Hudlow, 1984).

On a worldwide scale, flash floods are characterized by a disproportionately high mortality rate when compared to other types of flooding. According to Jonkman (2005), the mortality rate for flash floods is nearly 4%, while the ratio for other types of flooding is significantly less than 1%. On average, there are more than 5000 fatalities annually due to flash floods on a global scale. India is one of the most flood-prone countries in the world. One of the principal reasons for floods in

India is heavy rainfall during the monsoon period. In India, precipitation events are typically classified as extreme when the amount of rainfall exceeds 150 mm per day, which can result in the occurrence of floods across the country (Goswami *et al.*, 2006). Flash floods usually occur in sloping lands where heavy rainfall and cloudbursts are common.

Materials and Methods: Both primary and secondary data have been utilized in the study. Exploratory and primary data were collected from a questionnaire survey on the population directly affected by the flash flood during the field survey. Secondary data have been collected from various sources and institutions.

Study Area: Mangkolemba is a town and sub-division of Mokokchung district, Nagaland. It is located between Jangpetkong and Japukong ranges. It lies between 26° 29' 55" N Latitude and 94° 26' 11" E Longitude at an altitude of 914 meters above mean sea level. It is situated at a distance of 40 km from Mokokchung town. Mangkolemba is the sub-divisional headquarter of three ranges viz. Jangpetkong, Japukong and Tsurangkong covering about 40 villages. Mainly inhabited by the Ao-Naga tribe, Mangkolemba has about 879 households and a total population of 3713 according to the Census of India (2011). The area of the catchment is around 200 hectares and is characterized by a dendritic type of drainage pattern. High-magnitude flood peaks generally occur at the basin outlet in areas of dendritic drainage patterns (Mukhopadhyay, 1999). The study area is characterized by moderate to high relief with elevations ranging from 320 to 795 m above sea level. Mangkolemba, like any other mountainous landscape, is vulnerable to a number of different risks. Furthermore, the extreme escalation of anthropogenic activities such as unplanned growth of settlements, infrastructures, mining, and expansion over hazardous zones in narrow valleys has led to an intensification of disastrous events in the study area.

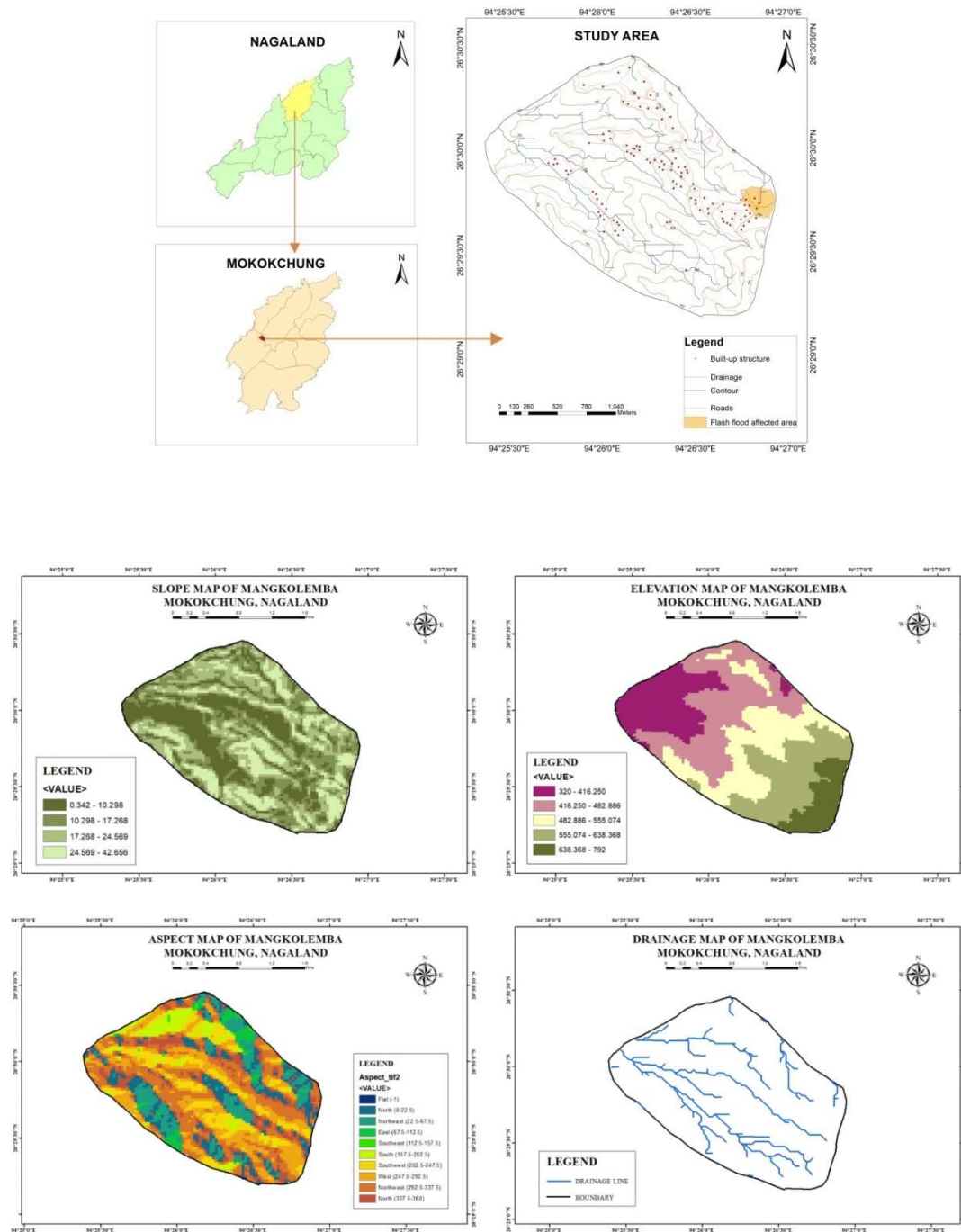


Figure 1: Study Area Map

Geology: The geology of Mokokchung District is largely depicted by its location in the Eastern Himalayan region, which is known for its complex geological history. The Disang Group of

lower and middle Eocene age, the Barail Group of upper Eocene and Oligocene age, the Surma and the Tipam group of Miocene age, and the Namsang beds of Miopliocene age represent the rock sequence. The geology of Mangkolemba falls under the Tipam sandstone and Barail group. The southwestern part of Mangkolemba consists mostly of well-bedded sandstones with shale intercalations. It is composed of medium-grained ferruginous sandstones with shale, mudstone, and clay. In comparison, the northeastern part of the study area is composed mainly of relatively younger rocks characterized by hard ferruginous sandstone with minor shales.

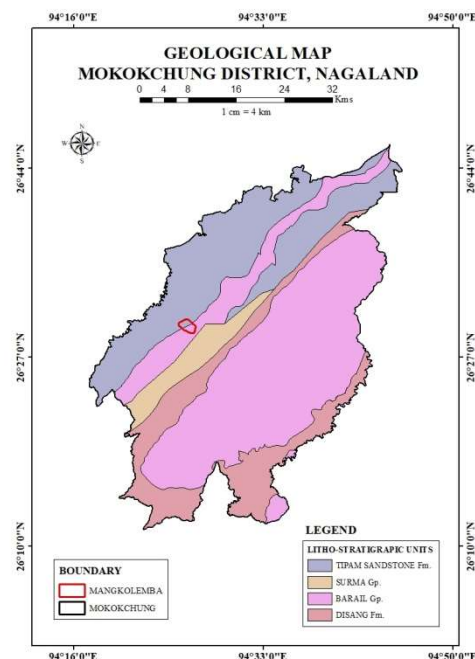


Figure 2: Geological Map of Mokokchung District, Nagaland

Rainfall Pattern: The Daily rainfall data of Mangkolemba town (Source: Soil and Water Conservation, Mangkolemba) over the period of 10 years from 2013 to 2022 has been analyzed. It indicates that the area receives an average of 2085 mm of annual rainfall, and the majority (around 70%) of annual precipitation is concentrated between the months of June and September during the peak rainy season (Figure 1a). Figure 1b shows the daily rainfall graph for the month

of August from 2013-2022. Mangkolemba received a total of 135 mm rainfall on August 10, leading to the occurrence of lash flash in the area.

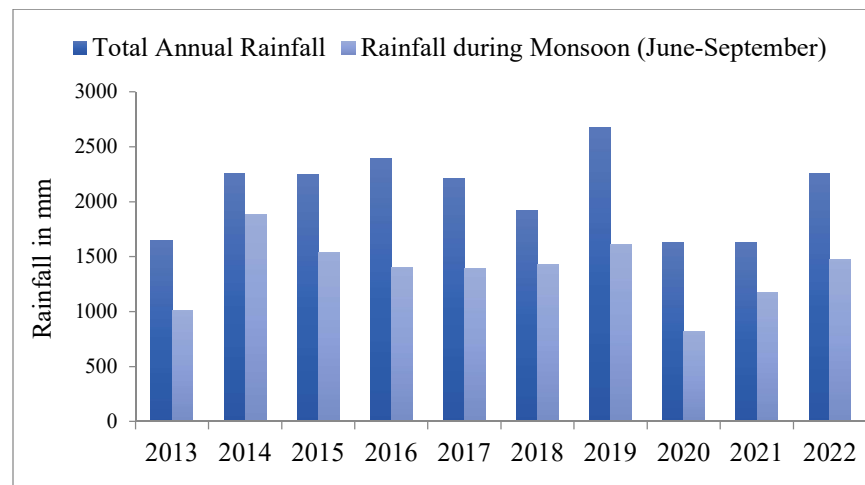


Figure- 3(a): Annual Rainfall of Mangkolemba (2013-2022)

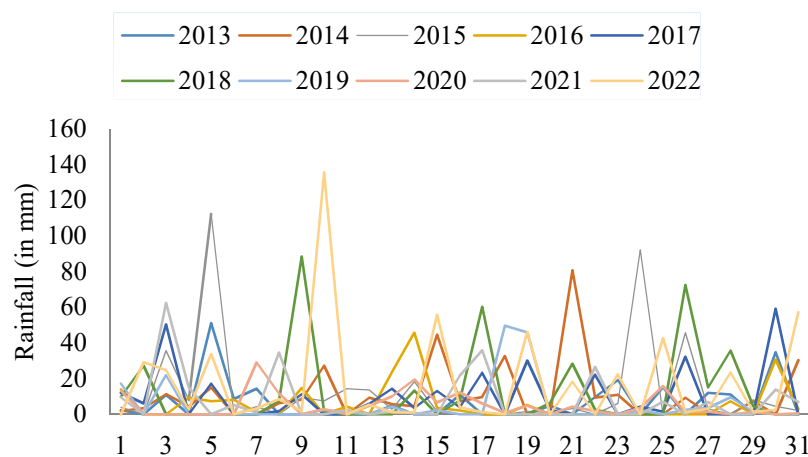


Figure 3(b): Precipitation during the month of July (2013-2022)

Flash Flood Scenario of Mangkolemba on August 10 2022: Mangkolemba received a rainfall of 135 mm on August 10 2022, triggering debris flows and flash flood. According to the locals, heavy rainfall started to pour from 1:00 A.M. On sensing the risk of calamity, residents evacuated their houses, those located in the sinking area and thereby no lives were lost. However, because they were unable to move their properties in the wee hours, the magnitude of

damage caused by the flash flood was enormous. Around 15 families were rendered homeless and properties in terms of lakhs were damaged following the flash flood and debris flows caused by the intense rainfall. Eight houses were completely damaged and a few other houses were partially damaged. A labor camp located in Khar-Mongchen Junction was swept away. The persons staying in the labor camp had a narrow escape from being swept away by the flash flood. The catastrophic event had a bad input on the residents as well as the neighboring area of Mangkolemba. Roads connecting Mangkolemba to neighbouring villages were blocked due to debris and rocks. The flash flood severely damaged paddy fields in Japu village neighboring Mangkolemba. Heavy vehicles and other several vehicles were inundated. Water draining in and around Mangkolemba overflowed, with a few rivers changing their course due to the incessant rainfall.



Figure 4: (A) Vehicles inundated by debris flow, (B) Damage to houses

Discussion and Conclusion: With the increase in greenhouse gases, the climate system is warming across the globe. For each 1°C rise in global average temperature, the atmosphere can hold approximately 7% more moisture (Trenberth, 2011). Additionally, a warmer atmosphere increases the risk of extreme rainfall events, eventually resulting in extreme floods and flash flood events across the globe. The impact of climate change is being experienced by Mokokchung district as well as Nagaland in general. Over the past few years, there has been a

surge of extreme weather and climate-related events. Heavy rainfall and associated landslides is a common phenomenon in Mokokchung District and Nagaland in general. It has now become more frequent and severe due to changes in climate.

Although numerous occurrences of landslides in the past have been reported during the rainy season, the flash flood which occurred on August 10, 2022, is a phenomenon that has never before happened in the study area, implying a change of climate and its adversities. The study area is characterized by a moderate to relatively steep slope, resulting in high-speed runoff generation. The primary cause for the flash flood in the area can be attributed to the relevant precipitation coupled with the initial moisture conditions of the affected area. The intense and excessive rainfall increased the frequency and risk of flash flood in the study area. It has also been observed that the habitation of the affected population was built in a sinking zone potentially susceptible to hazards.

Regardless of the drawbacks, the study highlights the need for awareness of flash flood risk in the region. With rapid development and an increase in population, there is a chance of more and more frequent flash floods in the areas that are already affected. Flash floods occur in limited temporal and spatial areas, yet they pose significant threats to a greater number of populations. Thereby, it is crucial for policy makers and the dwellers to be aware of such risks and take proper measures to reduce the impact of such events.

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