

Flood Hazard in Kasungu: Implications and Strategies for Disaster Risk Reduction, Resilient Infrastructure, and Catchment Management

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1 Background

During the month of December, the Malawi experienced a substantial increase in rainfall following a dry spell that had affected the country. This marked resumption of rains initially brought relief and renewed optimism, among farmers who had planted their crops during the onset of the rainy season and were anticipating improved growing conditions. However, the sustained and intense nature of the rainfall soon shifted from being beneficial to hazardous.

The persistent and heavy rains resulted in widespread flooding across the country, posing serious risks to lives, livelihoods, and infrastructure. According to a report from the Department of Disaster Management Affairs (DODMA), a total of 9,143 households, in 17 districts across the country, were affected. Four lives were lost as a direct consequence of the flooding events while 101 sustained various injuries. Rescue efforts saved a total of 354 people. In addition, critical infrastructure, including buildings as well as major road networks (for imports and exports) and bridges, suffered extensive damage due to the continuous flow and accumulation of floodwaters.

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The 2025-2026 Seasonal Climate Outlook

Cumulatively, normal to above-normal rainfall amounts in most areas of Malawi are anticipated. There is, however, notable varying distribution in time and space. For instance, October to December (OND) sub-season, holds a contrasting prediction for the northern region, where normal to below-normal rainfall is anticipated. The month of November also holds a normal to below-normal rainfall pattern across the country.

❖ *Department of Climate change and Meteorological Services*

Local Communities

We have been experiencing floods for sometime but this is my first-time to witness a disaster of this magnitude. We observed household items being washed down by flood waters. Maize fields completely washed away. It was terrible.

❖ *Mphomwa Disaster Risk Management committee member*

Transport

At Mpasadzi, we have opened an alternative route and installed a temporary bridge. However, because it requires frequent maintenance, it will be closed daily from 11am to 1pm until permanent works are completed.

❖ *Minister of Transport and Public Works*

Economic Impact

Transporters Association of Malawi (TAM) has said scores of trucks transporting fertiliser for the Farm Inputs Subsidy Programme as well as fuel were stuck due to the cut-offs.

❖ Nation Publications

While acknowledging the widespread impacts and severity of flood-related damage nationwide, this report places emphasis on a specific flood hazard that caused significant disruption to the road network along the M1 highway in Kasungu Mphomwa Area, at Mpasadzi Bridge. This report aims to highlight the localized effects of flooding on transportation infrastructure and the broader implications for mobility, safety, and economic activity. The lessons drawn from this incident can be applied to other areas with similar contexts.
The report is divided into the following section: catchment or watershed area of the Mpasadzi bridge, rainfall analysis (with a focus determining the extent of rainfall variability and climate change), impact of rainfall in the catchment and recommendations.

2 Watershed Delineation

To assess and clearly define the spatial extent of the study area, Mphomwa, a watershed delineation was first performed using SAGA GIS, after which additional map preparation and spatial analyses were completed using the open-source QGIS software. A watershed, also referred to as a drainage basin or catchment, represents a land area in which all surface runoff converges and drains toward a common outlet in a single direction. This concept is important for environmental planning and resource management, as land use practices and human activities occurring anywhere within the catchment directly influence the hydrological processes, water quality, and general health of the catchment area.



Fig 2. Aftermath of floods in Dwangwa (source: Malawi Weather Chasers

Within the delineated catchment figure 3, elevations vary considerably, ranging from approximately 622 meters at the lower reaches to about 1,815 meters at the highest points. This variation in topography plays a significant role in controlling runoff patterns, erosion processes, and drainage characteristics across the area. The total area of the catchment is estimated to cover approximately 6221.85 square kilometers, with its drainage network ultimately discharging into the Dwangwa River (note that during the same period, Dwangwa area experience floods-fig 2). Mpasadzi Bridge is situated roughly at the central portion of the catchment as seen on the map

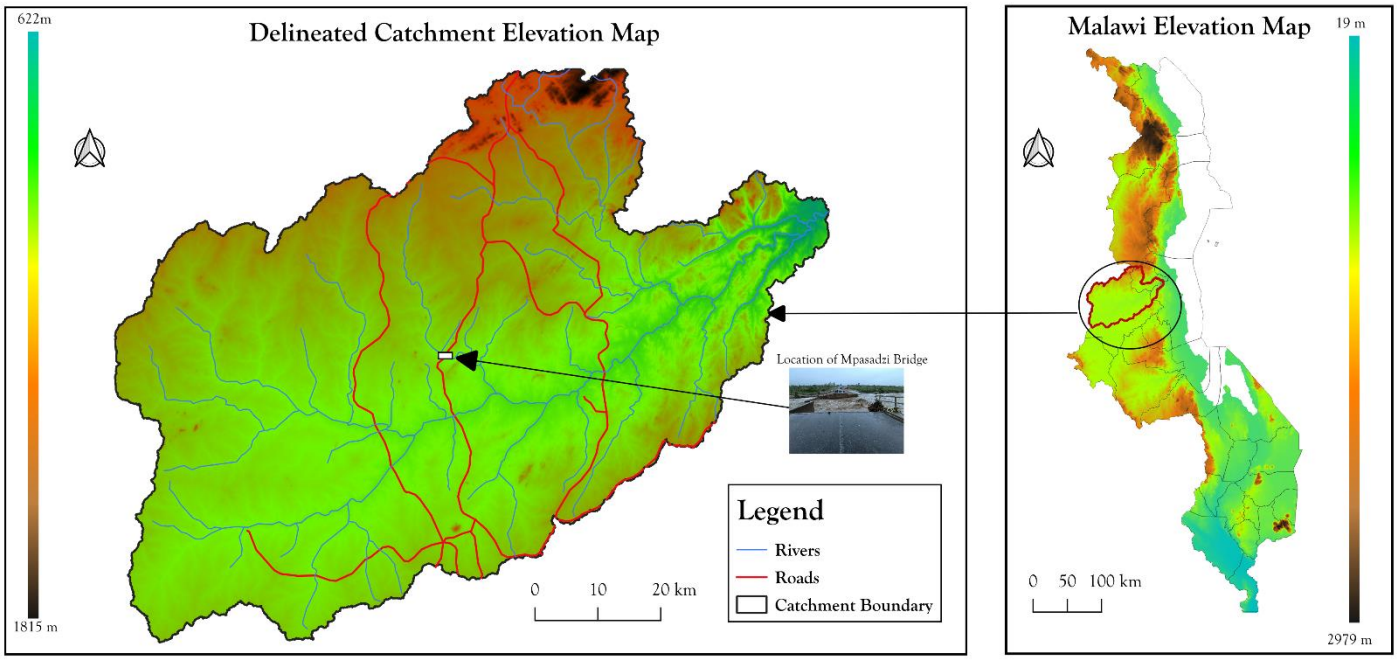


Fig 3. Delineated Catchment (Source: Authors-Picture of bridge social media)

3. Analysis of Past and Recent Rainfall

The report uses historic Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) data and Copernicus NETCDF data for December from 1981-2024 and December 2025 respectively to analyse rainfall patterns. A grid point from the rainfall dataset located within the delineated catchment at the upper Mpasadzi Bridge was selected to extract the data. The use of satellite data was driven by the lack of complete rainfall records for the area.Observed data from Mpasadzi-Mphomwa area from Department of Climate Change and Meteorology Services (DCCMS) was also used.

3.1 Climate Analysis

Rainfall ranges from very low values in some years to extreme peaks exceeding 350 mm in others. While several wet Decembers occur, especially in the mid-2000s, there is no clear long-term increasing or decreasing trend, indicating that December rainfall is largely characterized by high interannual variability rather than a consistent pattern.
The Mann–Kendall test (non-parametric statistical method for detecting trends in climate and hydrological data) results indicate a weak negative trend in December precipitation, as shown by Kendall's tau value of –0.091 and the negative S statistic (–86). This suggests a slight tendency toward decreasing precipitation over time in the catchment area. However, the trend is very small in magnitude. The p-value of 0.390 is considerably higher than the conventional significance level (α = 0.05), meaning the observed trend is not statistically significant. In this regard, the analysis indicates that December precipitation for the Mpasadzi catchment does not exhibit a statistically significant increasing or decreasing trend over the study period, and the variability observed is likely due to natural interannual fluctuations rather than a systematic change (no evidence of climate change. Figure 4 summarizes the findings

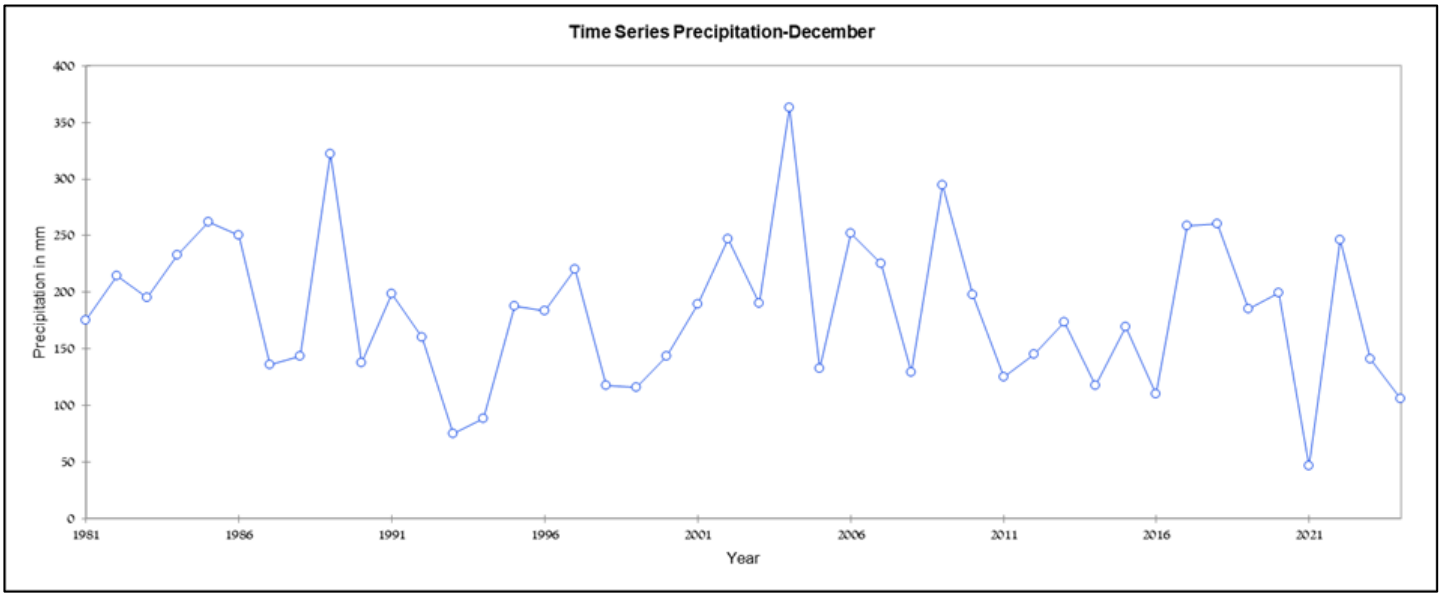


Fig 4. Trend of cumulative rainfall distribution (Source: CHIRPS)

3.2 Rainfall Anomaly Index: Extreme Event Analysis

The analysis further looked at the Rainfall Anomaly Index (RAI)-which in essence, is a simplified way of showing whether rainfall in a particular period is above or below normal. The RAI indicates that the majority of years fall within –1 and +1 in the catchment, representing normal rainfall conditions in December with only minor deviations from the long-term mean. These normal years dominate the record, suggesting that December precipitation is generally stable over time. Nevertheless, extreme events occur intermittently. Extremely wet years (RAI > +1) are observed in several periods, with the most pronounced peak around 2004, indicating exceptionally high rainfall and a heightened risk of flooding. Other wet extremes appear sporadically in the mid-1980s, late 2000s, and late 2010s. In contrast, extremely dry years (RAI < –1) occur in the early 1990s, mid-2010s, and early 2020s, with the most severe drought condition recorded around 2021. The RAI highlights that while normal years are most frequent, December rainfall is characterized by strong interannual variability, punctuated by occasional extreme wet and dry conditions rather than a consistent long-term trend. Figure 5 summarizes the RAI for the precipitation in delineated catchment

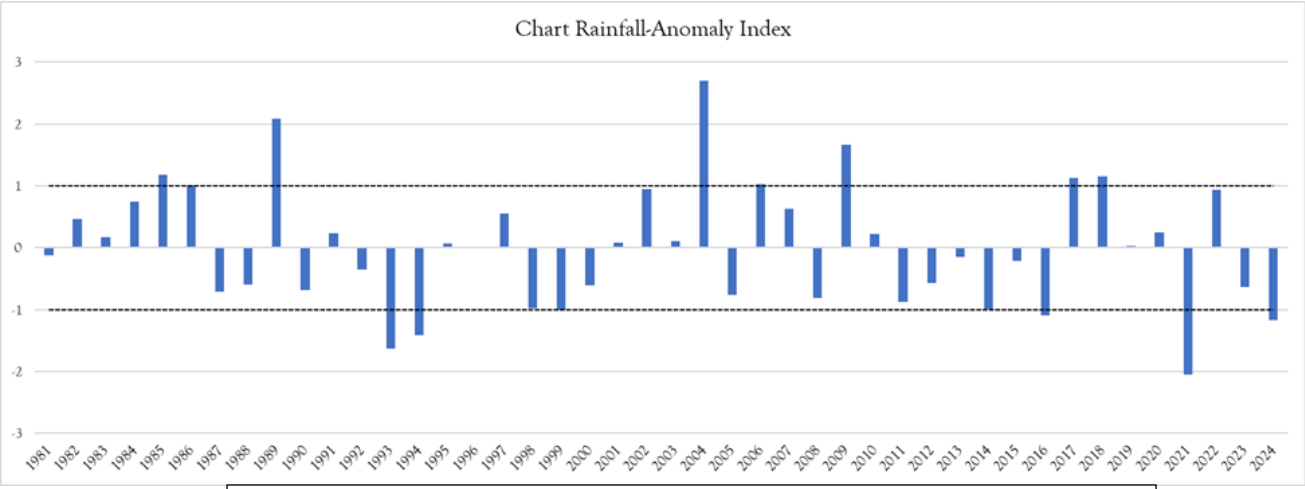
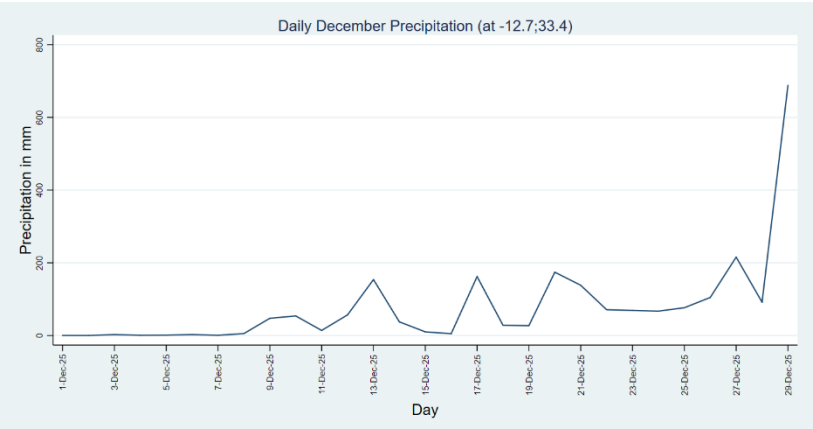


Fig 5. Rainfall Anomaly analysis (Source: CHIRPS)

3.3 December 2025 Rainfall Analysis

December rainfall patterns differ markedly between the remote sensed reanalysis data and the available ground observations, highlighting important contrasts related both to data characteristics and spatial representation. According to Copernicus data, rainfall in the upper Mpasadzi catchment was low in early December 2025, followed by a transition to wetter conditions around mid-December when several days of moderate to heavy rainfall were recorded. From 24 to 29 December, ERA5 indicates persistently heavy to extreme rainfall, with daily totals exceeding 60 mm. Rainfall intensified sharply on 26 and 27 December and culminated in an exceptional event on 29 December. This period coincided with widespread flooding in neighbouring Zambia, especially around Lundazi, approximately 40 km north-west of the reference point.

In contrast, the ground-based rainfall data, which were collected at a different spatial location and represent point-scale measurements rather than area-averaged conditions, show a highly variable and event-driven pattern. Rainfall amounts were moderate in early to mid-December, with 57.2 mm recorded on the 10th and 31.2 mm on the 22nd, followed by a pronounced but shorter-lived peak toward the end of the month. The most intense ground-observed event occurred on 29 December, with 175.2 mm recorded, after which rainfall declined rapidly to 70.1 mm on the 30th and just 8.1 mm on the 31st. While both datasets identify late December as the period of highest rainfall, Copernicus data shows substantially higher magnitudes and longer persistence of extreme rainfall. These differences highlight the importance of using both data sources together when assessing local flood risk.



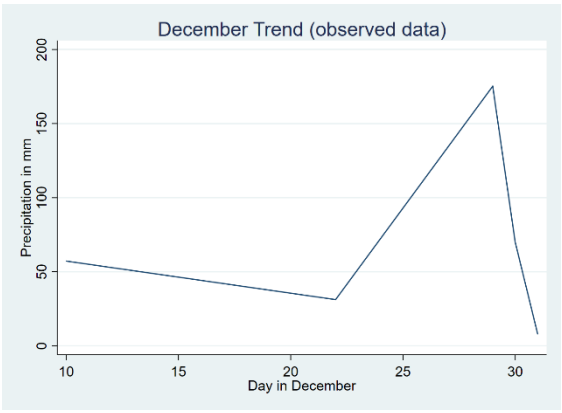


Fig 5. December 2025 rainfall trend (Source: CHIRPS, Met Office) Note: Copernicus website did not have rainfall data for the 30th and 31st at the time of downloading data

4. The Impact

A report by the Mphomwa Disaster Risk Management (DRM) Committees indicated that the recent flooding affected a total of 33 households, representing an estimated population of 229 people. Furthermore, the floods caused significant damage to livelihoods, with approximately 46 acres of maize fields being completely washed away by floodwaters. In addition, one residential house collapsed as a direct result of the flooding.

In terms of the overall scale and severity of the disaster, the most substantial impact was the destruction and subsequent cutting off of the Mpasadzi Bridge on the M1 road. This disruption severely affected transportation and access, limiting the movement of essential commodities such as food supplies, agricultural inputs, and other basic goods needed by the affected people around Mpasadzi and across the country.

Although no formal land use and land cover change assessment was conducted, DRM committees consulted in the aftermath of the flooding observed that widespread cultivation along riverbanks significantly contributed to the severity of the flooding impacts. Farming activities in these high-risk zones likely weakened the riverbanks and increased exposure to flood damage. Nevertheless, the committees emphasized that the magnitude and intensity of the flooding event were unprecedented in the area, exceeding past experiences and local coping capacities.

5. Recommendations

Based on the occurrence of flooding this year and its impacts on lives, infrastructure, and the M1 road network in Kasungu, the following recommendations are proposed to strengthen disaster risk management, road construction practices, and catchment management:

- Strengthen Disaster Risk Management by improving rainfall and river monitoring systems, enhancing early warning dissemination, and promoting community preparedness and response planning to reduce loss of life and property during flood events in accordance with the Sendai Framework.
- Enhance institutional coordination and emergency preparedness among disaster management authorities, road agencies, and local governments, supported by contingency plans and emergency funds to enable rapid response and post-flood recovery.
- Preposition essential goods and supplies such as fuel, emergency food, medical supplies, and other critical items within flood-prone regions to ensure continuity of services and timely humanitarian assistance when road networks are disrupted.
- Adopt climate-resilient road construction and maintenance practices, including elevated road embankments, adequately sized culverts, reinforced bridges, replacing old bridges and regular inspection and clearing of drainage systems, along major corridors such as the M1 road.
- Integrate flood risk assessments into transport planning to avoid high-risk flood zones where possible and to guide the design of infrastructure that can withstand extreme rainfall and flood events.
- Diversify transportation systems by strengthening alternative modes such as inland water transport and air transport to maintain connectivity, support emergency operations, and reduce economic losses when road infrastructure fails.
- Promote integrated catchment management through reforestation, protection of riparian buffers, and restoration of degraded areas to reduce surface runoff, erosion, and flood intensity.
- Regulate land-use practices within the catchment and encourage soil and water conservation measures, including contour farming and terracing, while actively involving local communities to ensure sustainable flood risk reduction.

ACKNOWLEDGEMENTS

We gratefully acknowledge the local communities and all individuals and institutions who generously shared data, knowledge, and time for this work. This work received no external funding. The views expressed are solely those of the authors and do not necessarily reflect the positions of their affiliated organizations.

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