INVESTIGATING THE IMPACT OF CLIMATE CHANGE ON RAINFALL-TRIGGERED LANDSLIDES IN KEGALLE DISTRICT

L. Gunasinghe [1], L. Gunawardhana [1,*], C. Samarasuriya [2], A. Wijemanna [3]

[1] Department of Civil Engineering, University of Moratuwa, Moratuwa
[2] Department of Earth Resources Engineering, University of Moratuwa, Moratuwa
[3] Meteorological Department, Sri Lanka

Landslides present a significant peril to lives and economies, notably in Asia where over 18,000 deaths and $8 billion in economic losses occurred due to landslides from 1998 to 2017. These events stem from a range of factors, including steep terrain, geological features, and extreme rainfall. Rainfall, influenced by climate change, emerges as a key factor in increasing landslide vulnerability. The IPCC projects intensified rainfall and droughts due to global warming, heightening landslide risks. Recognising this, the study focuses on the Kegalle District, Sri Lanka, to investigate the impact of climate-induced shifts in rainfall patterns on landslide susceptibility. The findings aim to provide decision-makers with insights for proactive measures.

The Kegalle District in Sri Lanka, a landslide-prone area, has experienced an increase in landslides despite a history of fewer occurrences. The study used the HadGEM3-GC31-LL model from CMIP6 to project potential shifts in future rainfall patterns. The baseline period selected for analysis is 1975-2015, while two Shared Socioeconomic Pathways: SSP2-4.5 and SSP5-8.5 were considered for future projections. Statistical downscaling was performed using the Long Ashton Research Station Weather Generator, and missing values (0.2%) were filled using the Multivariate Imputation by Chained Equations method. Daily rainfall data from Ratnapura station was distributed across the study area (Figure 1) using the gridded Climate Hazards group InfraRed Precipitation with Station (CHIRPS) dataset (with a grid resolution of 5 km x 5 km). A Python code generated bias-correction factors for accurate future rainfall projections. Historical landslide events categorised by the NBRO in the 2016-2021 period were correlated with days of excessive rainfall to gauge susceptibility.

Figure 2 shows the average number of days with daily rainfall exceeding 73 mm during the 2016-2021 period. The minimum rainfall threshold for triggering past landslides was identified using NBRO data. The number of days above this threshold was used to define the range of days required for triggering landslides, slope failures, and cutting failures (Table 1). Figure 3 shows potential changes in these events from projected rainfall by SSP2-4.5 during the 2031-2060 period. Results show that the extreme category (4.2-6 days/year) expands throughout the catchment area in the future compared to the observational period. Similar effects were observed in different magnitudes for both SSP scenarios in two different periods (Table 2).

The findings of this research concluded that the rainfall effect on landslide susceptibility can be significant and that climate change effects could exacerbate the likelihood of landslides in the future. To enhance the accuracy of the analysis, it is recommended to incorporate additional landslide-triggering factors for the susceptibility analysis.

Keywords: Climate Change, Landslides, Downscaling, GIS, Disaster Management

[*] Correspondence: lumindang@uom.lk

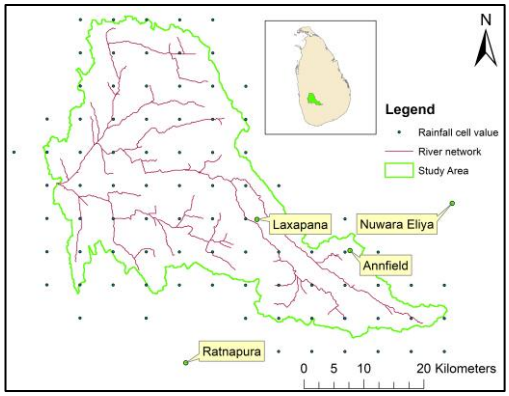

Figure 1: Study area and the coverage of CHIRPS data

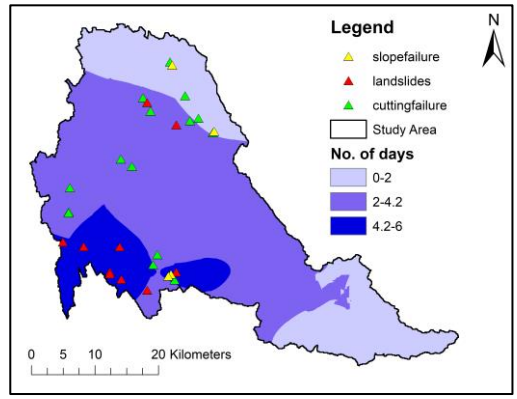

Figure 2: Distribution of the number of days exceeding the threshold

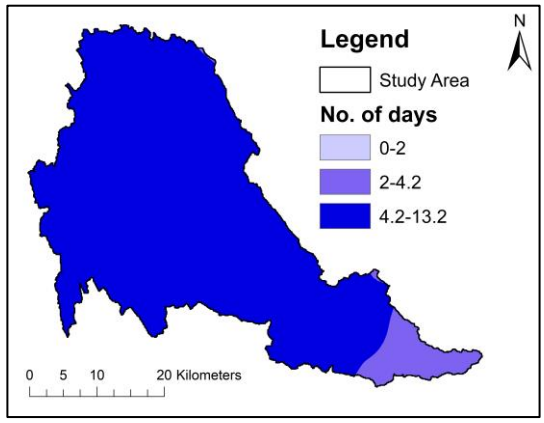

Figure 3: Distribution of the number of days exceeding the threshold for SSP2-4.5 (2031-2060)

Table 1: Accuracy of Results

Category	Number of events	Range of Days	Accuracy
Landslide	10	4.2-6	70%
Cutting Failure	15	2-4.2	60%
Slope failure	4	0-2	50%

Table 2: Comparison of Results

Scenarios	Observations	SSP2 (2031-2060)	SSP2 (2071-2100)	SSP5 (2031-2060)	SSP5 (2071-2100)
Area coverage of the extreme category (%)	12	94	100	100	100