Landslide and Its Impact on Agriculture in Kottiyoor Panchayath, Kannur District, Kerala

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Abstract

Kottiyoor panchayath in Kannur district, the birthplace of the Bavali River, faced a severe worst landslide due to heavy rains from August 12 to 16, 2017 (around eight landslides). Kerala received about 116% of the normal rainfall, with 310 mm of rainfall in the state in the first 48 h. According to the Kerala disaster management authority, the 2017 landslide in Kottiyoor panchayath was among the deadliest. The study area is undulating and densely forested with very steep slopes, and excess runoff from the upper hilly areas leads to landslides, leaving the site at a degraded level. Also, many houses and crops were damaged due to the flood, about 3 acres of agricultural land in the Ambayathode area of Kottiyoor panchayath permanently vanished, and 15 acres of cropland were damaged. However, a landslide was repeated in the same area after four years on August 02, 2022, due to heavy rains. As per the study, this terrain mainly belongs to the early stage of landform development and tectonic zone, especially agricultural activities in steep slopes and loose sedimentary soils are prone to erosion and induced slope failure in this region. The only way to prevent landslides in this area is to avoid human activities on the slope of these areas.

Keywords

Agriculture · Kottiyoor panchayath · Landslide · Rainfall

17.1 Introduction

Landslide is considered the most important and common geological process, and hazards occur when they have direct contact with the human habitational zone. The above said natural hazard occurs when part of a natural slope cannot support its weight (Intrieri et al. 2019). The Western Ghats and Nilgiri Hills, which are the stable domains of south India, witness frequent landslide events, mainly due to rains during the South-West and North-East monsoons causing misery to people (Bhasin et al. 2002; Kumar and Sanoujam 2007; Petley et al. 2007; Avasty et al. 2009; Ganapathy et al. 2010; Mayavan and Sundaram 2012; Gurugnanam 2013). Kerala faced one of the worst landslides in 2017, with almost all parts of the state affected by this natural phenomenon, including the Kannur district. Unplanned development and encroachment of lands in the river vicinity have made the Kannur district prone to landslides in hilly areas and have led to floods. However, the relationship between landslides and

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rainfall occurrence is very complex. There is no generally accepted method for rainfall-induced landslide prediction. A total of eight landslides occurred in the present study area of Kottiyoor panchayath, followed by five landslides in Ayyankunnu, Eruvessy, and Iritty. Landslide countermeasures are a formidable problem; hence, there is a crucial need for enhanced and modern techniques to analyze slopes and landslide susceptibility (Anbalagan and Parida 2013). The present chapter mainly aims to understand the impact of landslides on agricultural land and their natural and anthropogenic influence.

17.2 Study Area

Kannur district of Kerala has a coastal line on the western side and mountains on the eastern side; its topographical features have a natural slope toward the west. Kottiyoor panchayath, lying between 75° 50′ 00″–75° 55′ 00″ E and 11° 50′ 00″–11° 55′ 00″ N, is a hilly, undulating, and steeply sloping terrain and the extreme eastern part borders Karnataka state with forests at an altitude of 1689 mt. (Figs. 17.1, 17.2 and 17.3a). The study area is drained by river Bavali, a tributary of the Valapattanam River, and it has fourth stream order (Fig. 17.3c). The area is mainly underlain by metamorphic gneiss with patches of schist and amphibole (Fig. 17.3b). Most of the area is covered by dense forest, including evergreen forest and, deciduous forest, grassland, resulting in very few habitats and more agricultural activities around the Bavali River (Fig. 17.3c).

17.3 Data and Methods

The study area was first analyzed from the secondary data source to understand the current status. The LANDSAT 8 OLI/TIRS C2 L1, 2019 satellite

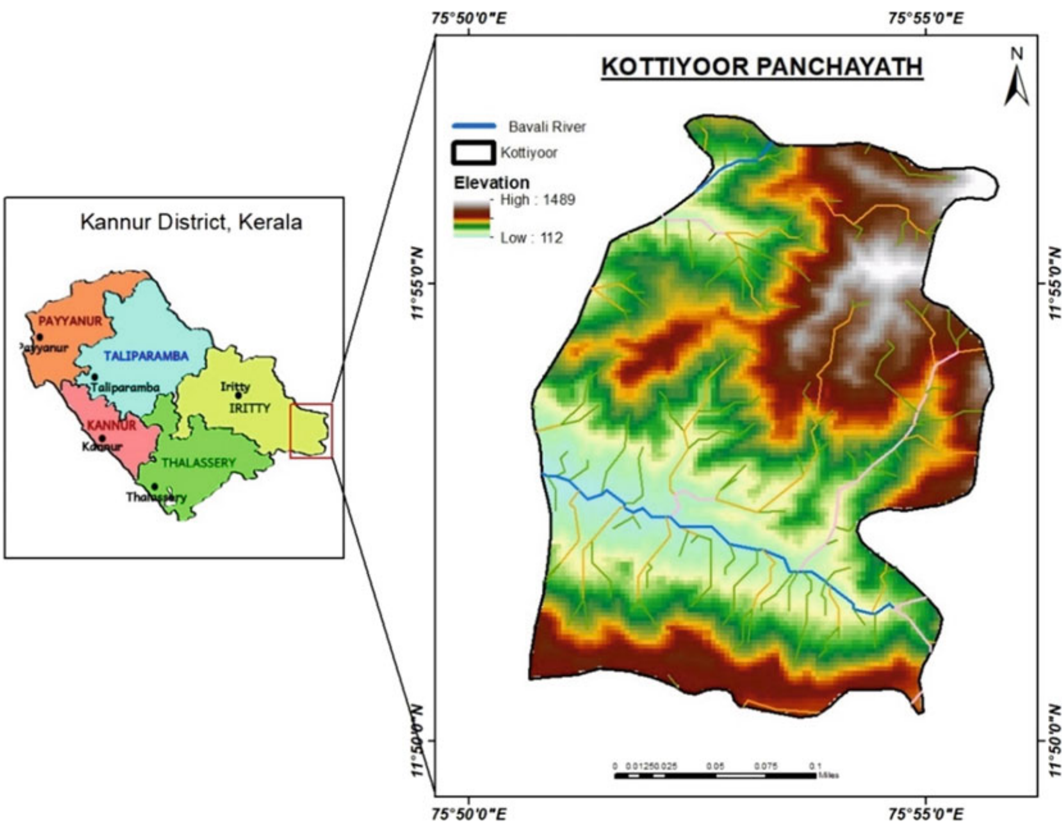

Fig. 17.1 Location map of the study area

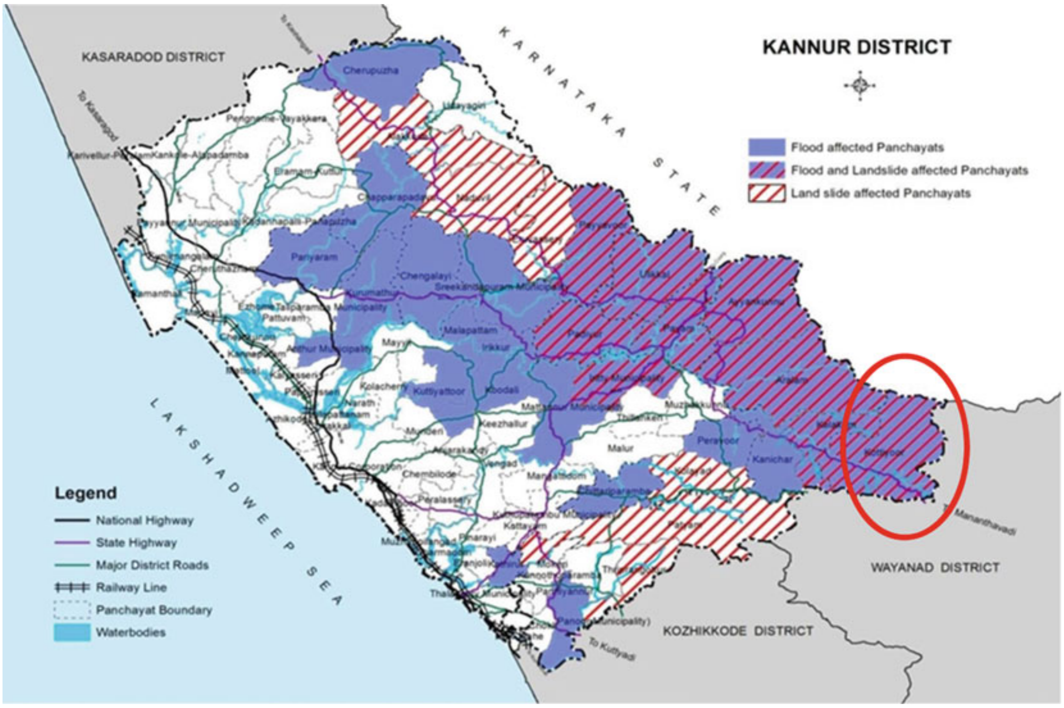

Fig. 17.2 Landslide and flood-affected panchayaths in Kannur district (*Source* GSI, Kerala)

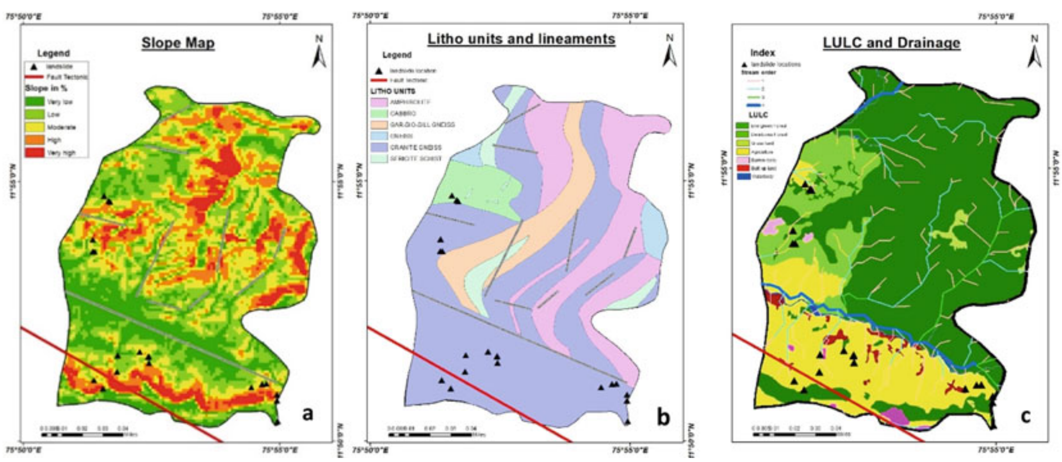

Fig. 17.3 Detailed mapping of the study area; **a** slope, **b** rock units and lineaments with landslide locations, **c** land use and land cover with drainage order

image has been used, and a classification pattern was established for the study area. Geology, soil, geomorphology, and lineaments help understand the cause of landslips (Bhukosh 2019). SRTM DEM image is also used for terrain analysis, such as elevation, slope, and drainage mapping.

17.4 Results

In the last three decades, more than 471 major disasters have occurred in India, and an estimated 1 lakh people have lost their lives. These disasters not only cost lives but also have an irreparable impact on the nation's economy, environment, infrastructure, and other assets (Sooraj et al. 2020). Small creeks, canals, rivers, and water bodies get submerged during floods, and landslides are the main reason behind this. Agriculture land is irreparably damaged.

Kottiyoor, the origin of Bavali River and Panchayath in Kannur district, experienced one of the worst landslides on August 16, 2017, with a total of eight landslides due to heavy rains (Figs. 17.4, 17.5 and 17.6), about 116% more than the usual rainfall in Kerala. In the first 48 h of rain, the state received 310 mm (12 in) of rain (www.deccanchronicle.com). The study terrain is undulating and densely forested with very steep slopes. According to a report by Kasthoori Rangan and Gadgil.

Sooraj et al. (2020), Kottiyoor is the 23rd Wildlife Sanctuary in Kerala, which belongs to the ecologically sensitive units and the landslide-susceptible zone (Fig. 17.2). The Kerala disaster management authority reported

Fig. 17.4 On August 16, 2017, Thursday, a landslide occurred at Ambayathode in Kottiyoor (www.thehindu.com)

Fig. 17.5 Agricultural land has been destroyed by landslides in Kottiyoor (Screengrab/manoramanews Tuesday, August 02, 2022—15:12)

the 2017 landslide in Kottiyoor panchayath as one of the most dangerous landslides that ever happened. The surplus water flow from the upstream hill areas leads to landslips, leaving the place in a devastating condition. After four years, the same area again experienced a landslide due to heavy rainfall (> 204.5 mm) on August 02, 2022 (Fig. 17.7). This is mainly because of the youth stage of landform development, tectonic zone along major lineaments, agriculture activities at the steep slope, and saturated lateritic sedimentary soil at the top; shrink and swell weathering leads to vulnerable for erosion and seepage water emanating from the slope (Xu et al. 2020). According to the Central Meteorological Department, on August 02, 2022, strong winds of 40–50 km per hour were gusted along the Kerala-Lakshadweep coast.

As a result of this, it is suggested that irrigation loss from landslides represents a growing agricultural threat and geologic conditions with certain climatic (Duan et al. 2014). Furthermore, recorded landslides worldwide indicate that heavy rainfall causes a collapse in the high effective permeability of soils and high saturation of soil masses (Xie et al. 2021; Jin and Dai 2007). In other words, the more unstable subsurface geologic layers are when saturated due to percolating water from irrigation projects, the more prone to landslides due to a rise in water table level (Slack et al. 1996).

Fig. 17.6 Google earth image of landslide occurred at Ambayathode on August 16, 2017

India Meteorological Department's District Rainfall Forecast
Issue Date 02.08.2022; Time: 10:00 hrs.

District	02.08.2022	03.08.2022	04.08.2022	05.08.2022	06.08.2022
Thiruvananthapuram	ISOL 'H to VH	ISOL 'H to VH	ISOL H	L to M	L to M
Kollam	ISOL 'H to VH	ISOL 'H to VH	ISOL H	L to M	L to M
Pathanamthitta	ISOL 'H to VH	ISOL 'H to VH	ISOL 'H to VH	L to M	L to M
Alappuzha	X H	X H	ISOL 'H to VH	L to M	L to M
Kottayam	X H	X H	ISOL 'H to VH	ISOL H	L to M
Ernakulam	X H	X H	X H	ISOL H	L to M
Idukki	X H	X H	X H	ISOL H	L to M
Thrissur	X H	X H	X H	ISOL H	L to M
Palakkad	X H	X H	X H	ISOL H	L to M
Malappuram	X H	X H	X H	ISOL H	L to M
Kozhikode	X H	X H	X H	ISOL 'H to VH	ISOL H
Wayanad	X H	X H	X H	ISOL 'H to VH	ISOL H
Kannur	X H	X H	X H	ISOL 'H to VH	ISOL H
Kasaragod	ISOL 'H to VH	ISOL 'H to VH	X H	ISOL 'H to VH	ISOL H

Fig. 17.7 Rainfall data of Kannur district on August 02, 2022

Several natural factors are likely to occur simultaneously. In some cases, one risk triggers another (Sooraj et al. 2020). Sudden inundation of rainwater from the hilly areas of Kottiyoor has caused flooding and simultaneous landslides in the lower catchment of the Bavali River, an area occupied by prime agriculture and plantation lands (Fig. 17.3c). About three acres of agricultural land and plantation crops in the study area have been permanently wiped out, and about 15 acres of cropland have been damaged (Fig. 17.5). Accumulation of silt, stones, muddy soil, etc., in agricultural fields, increased soil acidification, loss of topsoil fertility, and mass mortality of soil organisms such as earthworms (Xu et al. 2020; Gu et al. 2019). This natural calamity results in a reduction of latex production in rubber plantations and an increase in crop diseases such as bark rotting, bacterial leaf blight in paddy, and fungal disease in pepper defoliation (Kennedy et al. 2015). The only way to prevent landslides in this area is slope reduction and avoiding construction on steep areas.

17.5 Conclusion

The chapter focuses on the impact of landslides on agricultural land in villages of Kottiyoor panchayath. The time span, selected is 2017 and 2022. Causes of landslides in Kottiyoor panchayath are changes in natural slope by blocking natural grooves and streamlets for cultivation; heavy rains for a week leading to build-up of excess pore water pressure; reducing the cohesive strength of soil particles due to a high degree of saturation, eventually leading to floods and landslips. Although based on land use patterns and geological factors, this area belongs to landslide-prone areas. Proper planning should be done to reduce the severity of disasters caused by natural calamities in the future and help in the sustainable development of hilly areas. Aside these, for better preparedness especially in the hilly landslide-prone (small) regions, rational management (in the shape of pre-disaster and post-disaster management) is earnestly needed. Additionally, under the giant task of regional disaster management, participation of local people and grassroots institutions is also necessary. In this way, we can go forward not only for sustainable development as well as sustainable agricultural avenue.

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