Review Paper:

Analyzing Flood Patterns and Impacts across Various States in India: A Comprehensive Study

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Abstract

India is now regarded as a developing country just after China and the country gained ground significantly in the areas of innovation, training and industrialization. It is implied that the progress of any country in terms of money development is directly tied to the progression of the country. However, floods are the most common natural phenomenon in India. The flood caused massive death tolls, structures and financial emergencies. Flood played an important role in human development, economics and culture of Karnataka, Kerala and Assam. This study has been related to the natural disasters over the years 2018, 2019 and 2024 in Karnataka, Kerala and Assam.

Three natural disasters occurred in different States, altering people's perceptions of life and leaving a lasting impact. As a result, it is critical to consider the flood-affected areas in all three States to gain a better understanding of the life and financial losses, as well as crucial steps to be implemented in the following years to mitigate the effects of the disaster.

Keywords: Rainfall analysis, Infrastructure loss, Life loss, Flood, Disaster.

Introduction

Floods are the most prevalent natural and man-made catastrophies in India, causing bridge failures. Over the previous two decades, severe rainfall has caused more than 20 bridge collapses. Floods in Kerala are one of the causes of natural disasters. Flood in Assam is another example of a natural hazard in the northeast of India. An approximate graph of the record of numerous events that occurred during that time, may be derived from media, newspapers and literary reports.

Since June 25, 2024, the State of Assam has been facing floods caused by severe to extremely high rains and rising water levels in several rivers. On July 17, 2024, the flood impacted 16 districts and 49 revenue circles including Biswanath, Cachar, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Kamrup, Kamrup Metro, Karimganj, Majuli, Morigaon, Nagaon, Nalbari and Sivasagar. Figure 1 shows the various districts of Assam affected by heavy rainfall.

According to the IMD data, the maximum rainfall reported in various districts during the previous 24 hours was 120 mm in Cachar and 80 mm in Tinsukia with an average of 21.1 mm. According to the Central Water Commission bulletin, the Brahmaputra and two other rivers are running over their danger levels.

Data sources include media, literature and official reports from Assam, Kerala and Karnataka, among others. The terms used in the web search are flood in Karnataka, Kerala and Assam, rainfall criteria, waterlogging regions, dams and water storage. In addition, several periodicals such as Down to Earth, Memorandum Assam, Karnataka and Kerala Floods (2018, 2019 and 2024) are used to learn about the changes in the Assam flood.

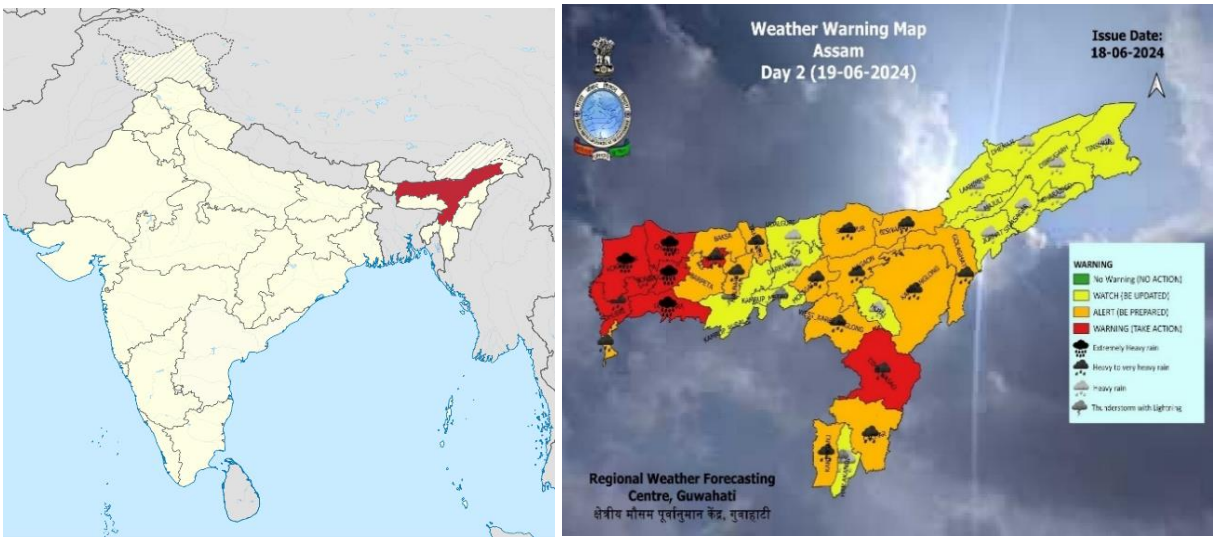

Figure 1: Geographical map of Assam

Review reports: According to the United Nations, events triggered by certain risks can have a significant impact on a community's social and financial well-being. If a seismic tremor occurs on an uninhabited island, no one is affected. Catastrophes need to influence humans. Flooding in a well-planned area can be devastating. Flooding in an unprepared area may be catastrophic, destroying crops and forcing people to leave their homes[3]. Similarly, strong rains fall in many places of the world. Catastrophic disasters can occur when precipitation exceeds expectations and safety precautions are not in place. The issue is not the precipitation itself, but the outcome of it. Natural disasters significantly impacted the State's social and economic circumstances in 2018, 2019 and 2024.

Floods in Assam (2018, 2019 and 2024)

Assam is a State in northeastern India that borders Bhutan and other northern states known as the Seven Sisters State. Assam is located near the Himalayas and features breathtaking natural vistas including several valleys, rivers, streams and waterfalls. Assam shares borders with Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, Bangladesh, Bhutan and West Bengal. The approximate latitude and longitude coordinates of Assam are Latitude: 26.2006° N and Longitude: 92.9376° E. According to the IMD data, the maximum rainfall reported in various districts of Assam in 2018 in one hour was 120 mm in Cachar and 80 mm in Tinsukia, with an average of 21.1 mm.

According to the Central Water Commission (CWC) report, the Brahmaputra and two other rivers have exceeded their danger levels. One person died in the preceding 24 hours, bringing the total number of fatalities to 113 during the current flood. A total of 3,337,981 people have been affected due to the flood. Dhubri has been impacted the most in the last 24 hours, with over 80,000 persons affected, followed by Nagaon (77,500) and Cachar (roughly 72,000). Table 1 shows the actual and normal rainfall in various district of Assam in 2018.

The flood has caused significant infrastructure damage, with 24,501 houses reported as damaged (3,306 completely and 21,195 partially). Eighty-four relief camps were built to house 15,476 inmates. Furthermore, 85 aid camps and distribution facilities were operational in eight regions, serving 24,336 affected people. A total of 823 settlements were inundated and 16,673.86 hectares of crops were destroyed throughout the state.

Table 1
Actual and Normal Rainfall Data of Assam 2018

S.N.	District	Actual Rainfall	Normal Rainfall
1	Baksa	1321.2	2410.6
2	Barpeta	2065.5	2410.6
3	Bongaigaon	1748	2253.7
4	Cachar	1642.7	1860.2
5	Chirang	2784.3	2253.7
6	Darrang	359.8	1246.7
7	Dhemaji	591.2	1998.9
8	Dhubri	1140.8	1891.7
9	Dibrugarh	1350.1	1629.9
10	Goalpara	1164.9	1666.6
11	Golaghat	922.4	1038.3
12	Hailakandi	1216.1	1591.1
13	Jorhat	1242.1	1276.3
14	Kamrup (Rural)	814.5	1129.9
15	Kamrup Metro	811.5	1129.9
16	Karbi Anglong	661.7	854.2
17	Karimganj	1980.5	2125.9
18	Kokrajhar	2427.8	2775.4
19	Lakhimpur	1995.3	1998.9
20	Morigaon	779	1197.2
21	N.C.Hills	751.9	969
22	Nagaon	719.5	1109.7
23	Nalbari	1158.6	1549.8
24	Sonitpur	1088.9	1300
25	Sibsagar	1057	1156.8
26	Tinsukia	1174.6	1600.8
27	Udalguri	1405.2	1246.7

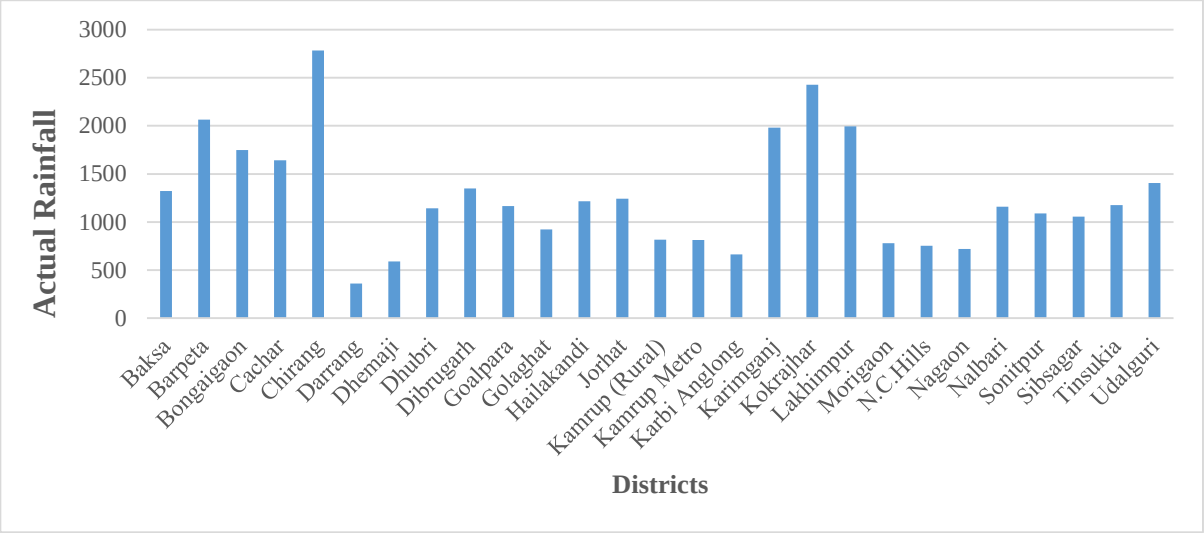

Figure 2: Graph shows the relationship between the Actual rainfall in the monsoon season from various districts

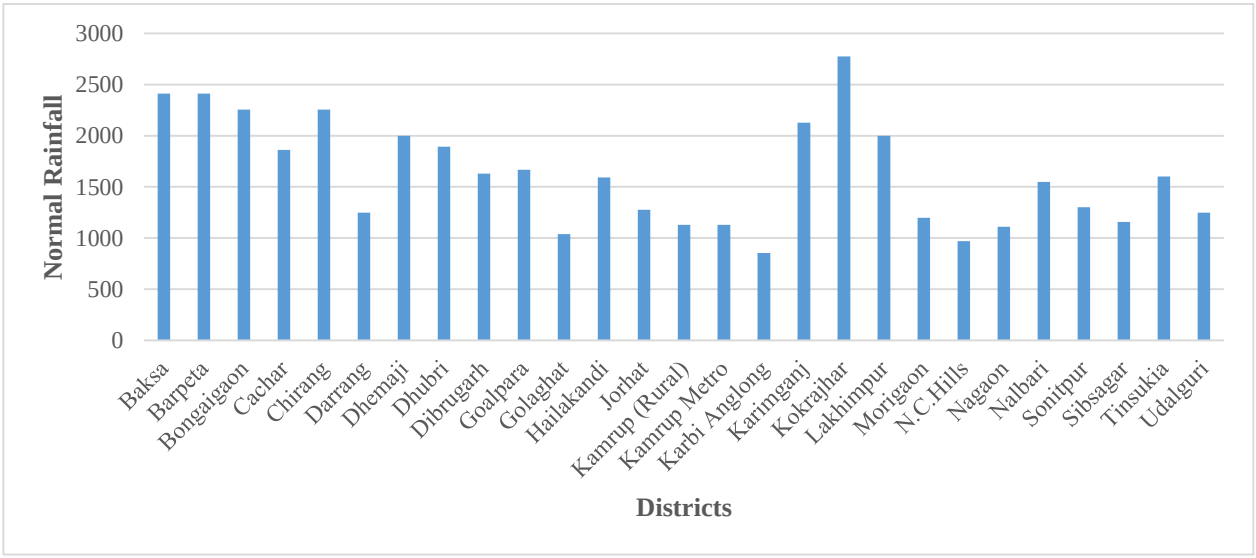

Figure 3: Graph shows the relationship between the Normal rainfall in the monsoon season from various districts

Figure 2 shows that districts i.e. Chirang (2784.3 mm) and Kokrajhar (2427.8 mm) have significantly higher rainfall compared to others like Darrang (359.8 mm) and Dhemaji (591.2 mm). In the second phase, districts in the central range such as Barpeta (2065.5 mm) and Lakhimpur (1995.3 mm), have substantial rainfall but are not the highest. Some districts, such as Kamrup Metro (811.5 mm) and Nagaon (719.5 mm), received relatively lower rainfall.

Figure 3 shows that the districts of Assam including Baksa, Barpeta, Bongaigaon, Cachar and Chirang, among others, showed varied values in the provided data. Baksa and Barpeta showed a normal rainfall value of 2410.6mm, while Bongaigaon and Chirang had values of 2253.7mm. The district of Cachar had a relatively lower rainfall of 1860.2, whereas Darrang, with 1246.7, also showed a significant difference. Some districts, such as Kokrajhar (2775.4) and Karimganj (2125.9), reflected higher values, suggesting notable differences across districts. On the lower end, districts like Udalguri (1246.7) and Golaghat (1038.3) had smaller values compared to others. These variations indicate differences in a specific attribute that may be related to natural, demographic, or socio-economic factors.

Floodwaters damaged embankments, roads, bridges and other infrastructure in Bajali, Goalpara, Kokrajhar, Bongaigaon, Dhubri, Barpeta, Charaideo, Dhemaji, Dibrugarh, Golaghat, Jorhat, Kamrup, Karimganj and Morigaon. In flood-affected regions, critical utilities such as road connection, telephone communication, water supply and electricity supply were disrupted. Figures 4 (a) and (b) showed the flooding condition in Assam.

In 2019, the devastation began immediately during the rainy season. According to the Assam Disaster Management Authority, the floods began around July 8, leaving 12 July, 631 people got stranded in five locations. By July 10, this figure had risen to 2.07 lakh people spread throughout eleven areas. Over the next week, the immersion extended throughout the State. On July 18, 2.25 lakh people were staying in assistance camps. Figure 5 depicts the length of the Brahmaputra River near Guwahati between July 1st and

16th, 2019. Figure 5 illustrates that on July 1, the Brahmaputra stream, which runs through the city, was limited slightly. By July 16, it had developed into a bloated lump.

Figure 4(a): Flood images in Assam

Figure 4(b): Flood images in Assam

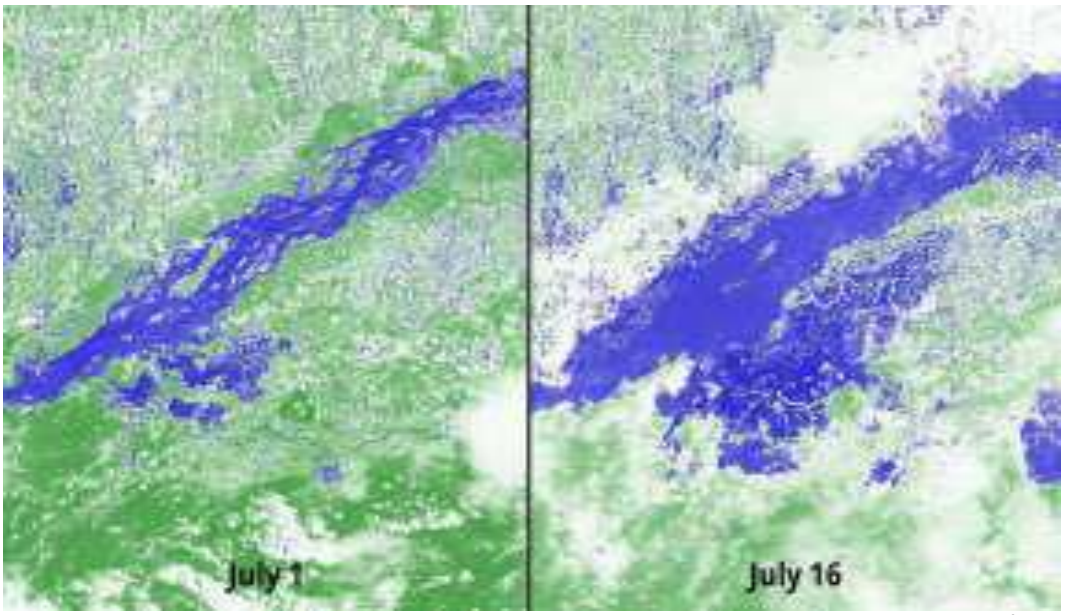

Figure 5: The Brahmaputra River near Guwahati, viewed on July 1 and July 16[4]

69 people were killed by rising floods across the State, which has seen particularly high rains in this monsoon season. The monsoon rains have wreaked havoc on the iconic Kaziranga National area, killing up to 209 animals in the 430-square-kilometer area located along the Brahmaputra River. Table 2 shows rainfall analysis of various districts of Assam in 2019. Figure 6 shows the normal rainfall ranges from a low of 830.4 mm in Karimganj to a high of 2639.6 mm in Kokrajhar. Districts like Barpeta (2319.1 mm) and Chirang (2239.3 mm) also received significant rainfall, while Kamrup Metro and Golaghat experienced lower levels of rainfall at 952.6 mm and 1053.9 mm respectively. The data highlights the variation in rainfall across the districts, which can be essential for planning agricultural activities, water management and disaster preparedness.

Table 2
Actual and Normal Rainfall Data of Assam 2019

S.N.	District	Actual Rainfall	Normal Rainfall
1	Baksa	1805.6	1193.4
2	Barpeta	2244.7	2319.1
3	Bongaigaon	2428.6	2248
4	Cachar	1762.7	1820.9
5	Chirang	2647.1	2239.3
6	Darrang	363.5	1221.8
7	Dhemaji	2314.7	1771
8	Dhubri	1543.6	2065.4
9	Dibrugarh	1315.1	1572.3
10	Goalpara	1690.2	1764.8
11	Golaghat	904.7	1053.9
12	Hailakandi	1477.7	1512.2
13	Jorhat	1150.2	1242.4
14	Kamrup (Rural)	903.7	1270.7
15	Kamrup Metro	885.5	952.6
16	Karbi Anglong	473.6	830.4
17	Karimganj	1868.1	2117.5
18	Kokrajhar	2980.8	2639.6
19	Lakhimpur	2018.3	1957.4
20	Morigaon	731.9617.5	1121.3
21	N.C.Hills	857.2	1051.5
22	Nagaon	617.5	982.3
23	Nalbari	1776.9	1555.7
24	Sonitpur	1136.4	1139.9
25	Sibsagar	840.7	1165.9
26	Tinsukia	1346.4	1483.6
27	Udalguri	1640.3	1374.9

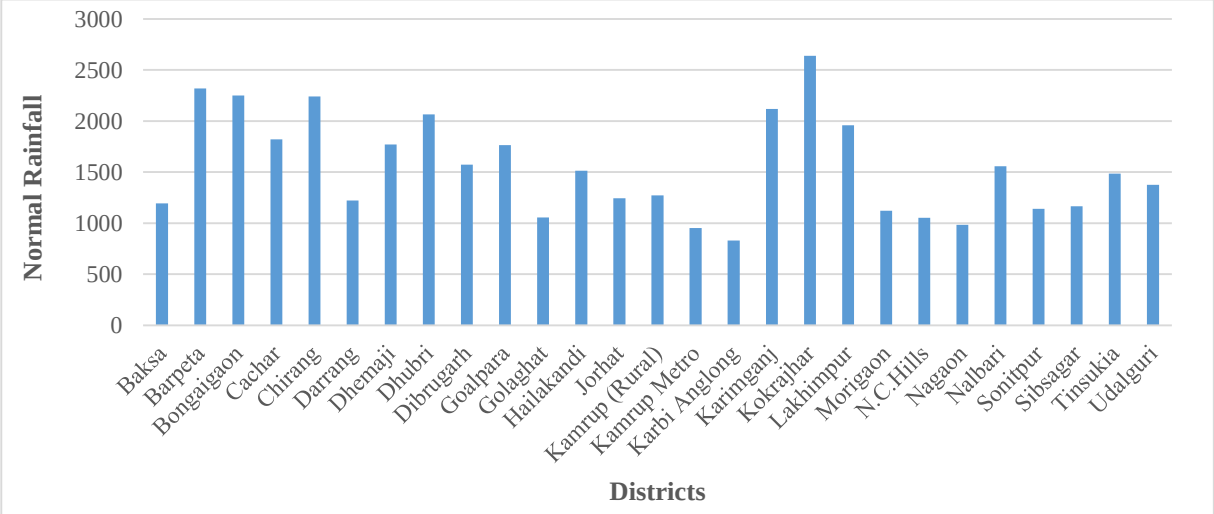

Figure 6: Graph shows the relationship between the Normal rainfall in the monsoon season from various districts

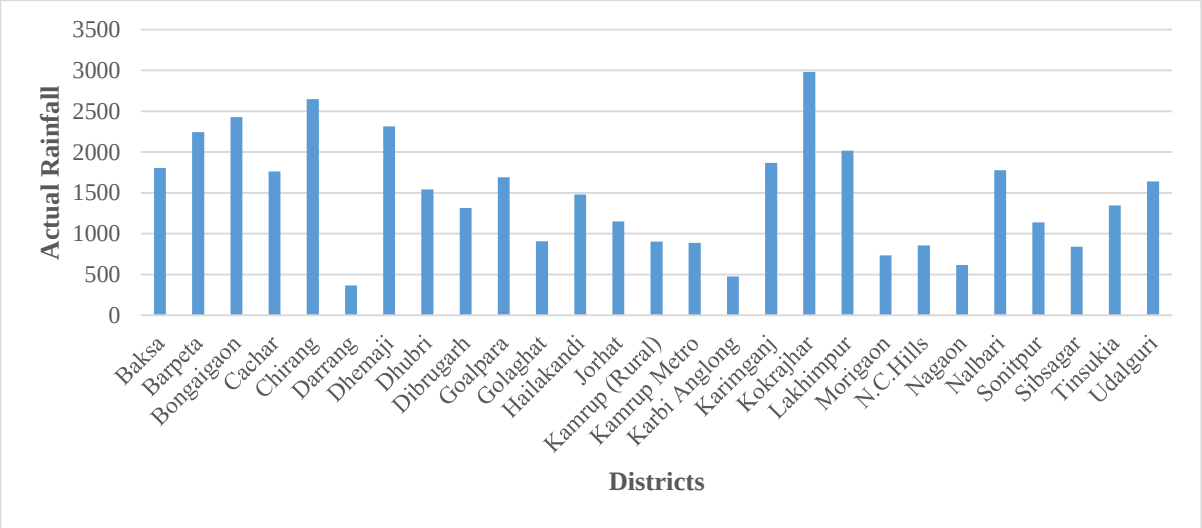

Figure 7: Graph shows the relationship between the Actual rainfall in the monsoon season from various districts

Figure 7 shows that rainfall data provided represents the actual recorded rainfall (in millimeters) for various districts. The district of Kokrajhar experienced the highest rainfall, with a significant 2980.8 mm, followed by Chirang at 2647.1 mm and Bongaigaon with 2428.6 mm. These districts saw considerably higher rainfall compared to others. On the lower side, districts like Darrang recorded a minimal 363.5 mm and Karbi Anglong received 473.6 mm indicating much lower rainfall levels in these areas.

Other notable districts included Dhemaji with 2314.7 mm of rainfall and Barpeta with 2244.7 mm**.** Several districts such as Dibrugarh**,** Tinsukia and Lakhimpur**,** experienced moderate rainfall ranging from 1300 mm to 2000 mm**.** Some districts i.e. Kamrup Metro and Sibsagar received relatively lower rainfall, with figures below 900 mm. Overall, there was a wide variation in rainfall across these districts, reflecting differing geographical and climatic conditions. The most casualties have occurred among hog deer, which are little animals with exceptionally wide round ears. In total, 111 hog deer, 18 wild boars, 17 rhinos, 12 sambar, seven swamp deer, three porcupines, two water buffaloes and one elephant perished in the inundated park.

On May 31, 2024, Assam's flood situation worsened, with over 349,000 people affected in 11 districts (Dhemaji, Dibrugarh, Nagaon, Hailakandi, Karbi-Anglong, West Karbi-Anglong, Dima Hasao, Karimganj, Cachar, Hojai and Golaghat) and people drowning as the water level of major rivers, namely Kopili, Barak, Katakhal and Kushiyara rivers, rose following incessant rainfall in the aftermath of Cyclone Remal. The situation worsened when six individuals died on Friday, May 31, 2024, bringing the total to ten. Assam's 25 revenue circles with a total of 560 villages were affected.

As of Tuesday, July 23, 2019, at least 64 animals had been rescued. The flood waves have damaged several lakh hectares of agriculture across the state, causing damage to dwellings, embankments and other structures. The road's connectivity to several remote settlements was impacted. According to the most recent Central Water Commission (CWC) report, the rivers Manas, Beki and Gaurang, all tributaries of the massive Brahmaputra River, were suffering severe flooding in the districts of Baksa, Kamrup, Nalbari, Barpeta, Kokrajhar and Dhubri.

The CWC recommended authorities to accelerate disaster relief operations as the rivers Aie, Champamati, Gaurang, Manas and Beki approached their peak flood levels. On July 23, 2019, the State got 42.9 mm of rain, compared to the usual of 13.5 mm over 24 hours. Meghalaya also received 86.6 mm of rain throughout the day, compared to a normal of 23.8 mm. Western Assam areas have been struck the worst. The IMD department predicted that severe rainfall in isolated areas will persist for the following three days, until the 25th of July. According to the India Meteorological Department (IMD), the intensity of rainfall in Assam has decreased since July 25, 2019.

Floods in Kerala (2018, 2019 and 2024)

The State of Kerala in India is located between 8°18' and 12°48' N latitude and 74°52' and 77°22' E longitude. Kerala is in the southwest corner of India, bordered by Karnataka and Tamil Nadu to the north, east and south and by the Arabian Sea to the east as shown in figure 8(a). The average annual precipitation in Kerala State is around 3000 mm. The southwest and northeast monsoons influence the State's rainfall. Approximately 90% of the rainfall falls during the six monsoon months.

The high-intensity storms that occur during the monsoon months cause significant flows in all rivers. The persistent and heavy precipitation that falls in the steep and undulating terrain, makes its way into the main rivers via numerous streams and water courses. Kerala saw unusually heavy rains from June 1 to August 19, 2018. This led to catastrophic floods in 13 out of 14 districts across the State. Figure 8 (b) shows the geographical affected area of the Kerala State in natural hazard 2018.

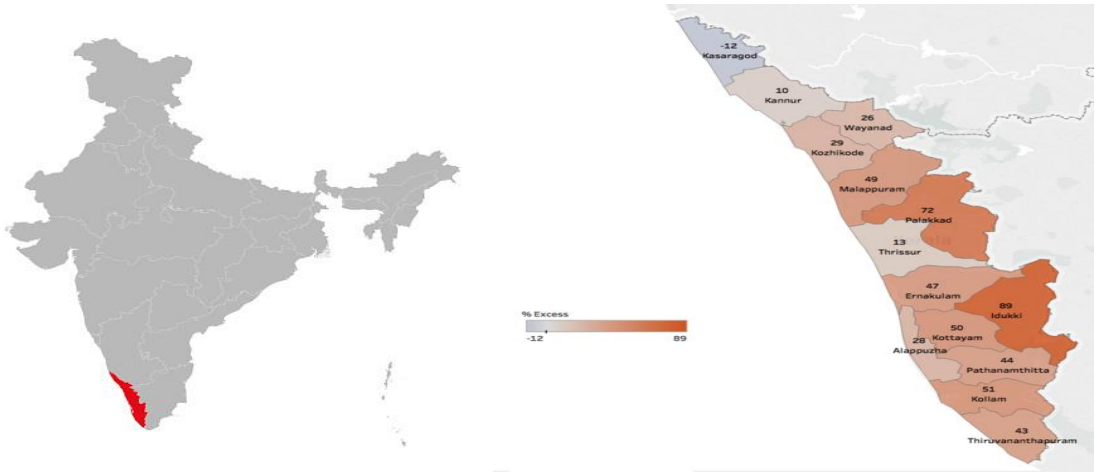

Figure 8 (a) Geographical area of the State of Kerala

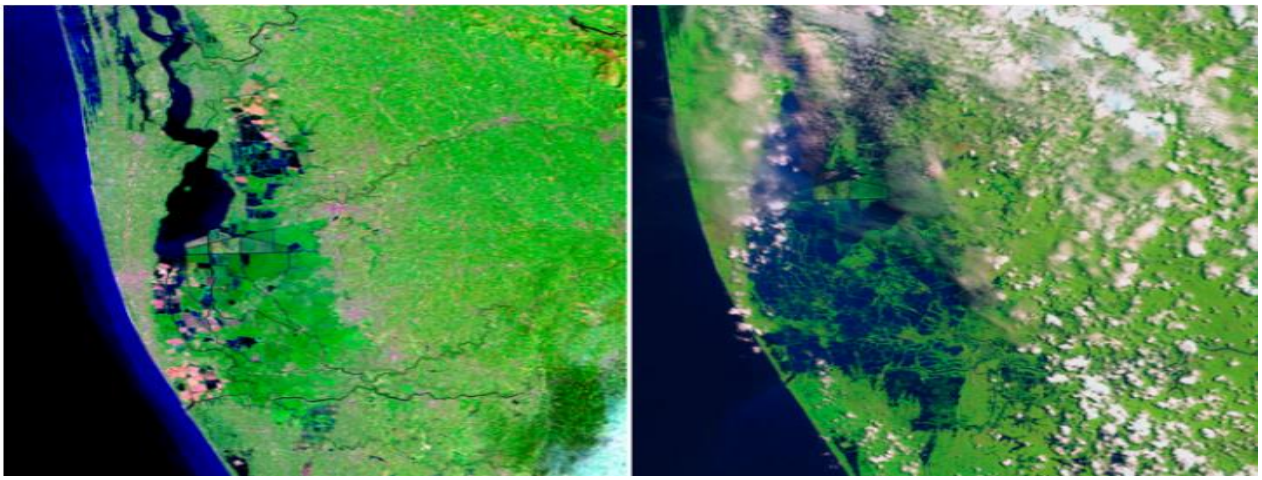

Figure 8 (b): Picture before and after Landslide in Wayanad District, Kerala

Table 3
Monthly actual rainfall, normal rainfall and rainfall percentage (Kerala, 2018)

Period	Normal Rainfall	Actual Rainfall	Departure from normal
June	649.8	749.6	15
July	726.1	857.4	18
August	287.6	758.6	164
Total	1649.5	2346.6	42

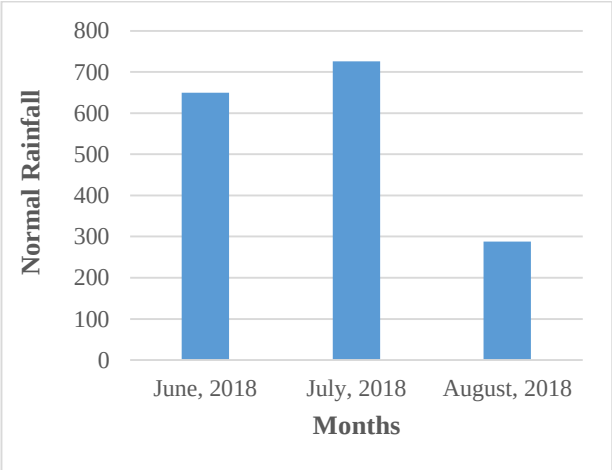

Figure 9: Graph shows the relationship between the normal rainfall in the monsoon season

Kerala experienced 2346.6 mm of rainfall from June 1 to August 19, 2018, compared to the anticipated 1649.5 mm. This rainfall was around 42% over usual. Kerala saw above-average rainfall in June, July and August (1st-19th). Table 3 displays rainfall data for each month as provided by IMD. Figures 9 and 10 showed the rainfall data for actual and normal rainfall in June, July and August. Table 4 showed the rainfall data of various districts of Kerala in 2018. Figure 11 shows that Kerala, as a whole, had received an average of 1701.4 mm of rainfall. Among the districts, Kasaragode recorded the highest rainfall at 2609.8 mm, followed by Kannur at 2333 mm and Wayanad at 2281.3 mm. On the lower end, Thiruvananthapuram recorded the least rainfall at 672.1 mm followed by Kollam at 1038.9 mm. Other notable districts include Kozhikode (2250.4 mm), Idukki (1851.7 mm) and Thrissur (1824.2 mm).

Figure 12 shows the rainfall data for various districts of Kerala showing significant variation in actual rainfall received across the State. The highest rainfall is recorded in Idukki with 3555.5 mm, likely due to its location in the Western Ghats, which trap moisture-laden winds. Kozhikode and Wayanad also received high amounts of rainfall, with 2898 mm and 2884.5 mm respectively, indicating that the northern and central parts of Kerala are generally wetter. On the other hand, the lowest rainfall was observed in Thiruvananthapuram with 966.7 mm, followed by Kollam at 1579.3 mm, which might be attributed to their coastal proximity and slightly different climatic conditions compared to the hilly regions.

Districts such as Alappuzha (2394.1 mm), Kannur (1784 mm) and Ernakulam (2573.3 mm) exhibit moderate rainfall. Most other districts i.e. Kasaragode, Kottayam and Palakkad, recorded rainfall between 2000 mm and 2600 mm, which was relatively high but not extreme.

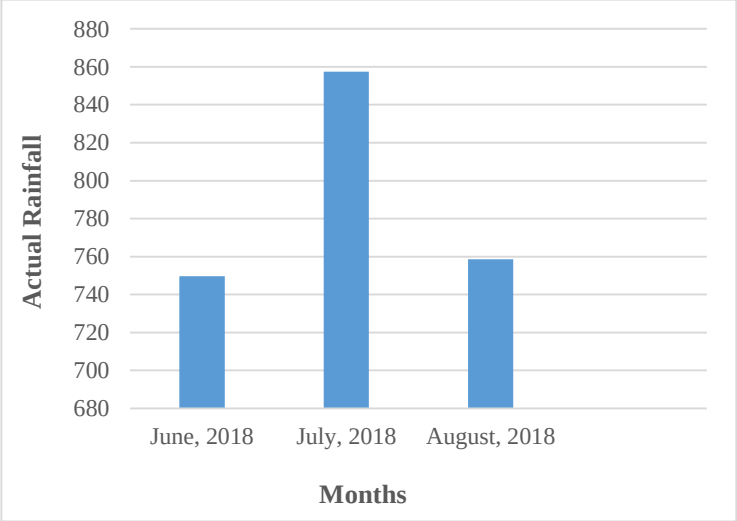

Figure 10: Graph shows the relationship between the actual rainfall in the monsoon season

Table 4
District-wise rainfall in Kerala during 1 June 2018 to 22 August 2018

S.N.	Normal Rainfall (mm)	Actual Rainfall (mm)
Kerala State	1701.4	2394.1
Alappuzha	1380.6	1784
Kannur	2333	2573.3
Ernakulam	1680.4	2477.8
Idukki	1851.7	3555.5
Kasaragode	2609.8	2287.1
Kollam	1038.9	1579.3
Kottayam	1531.1	2307
Kozhikode	2250.4	2898
Malappuram	1761.9	2637.2
Palakkad	1321.7	2285.6
Pathanamthitta	1357.5	1968
Thiruvananthapuram	672.1	966.7
Thrissur	1824.2	2077.6
Wayanad	2281.3	2884.5

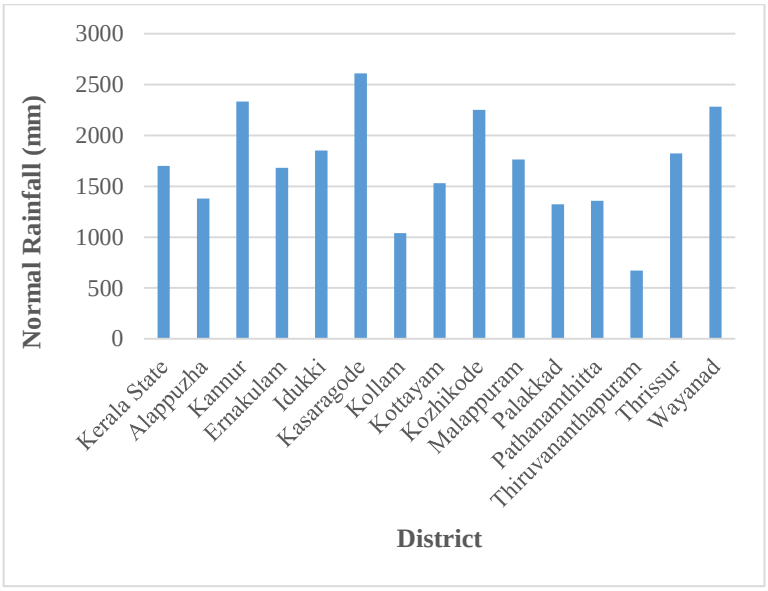

Figure 11: Graph shows the relationship between the Normal rainfall in the monsoon season from various districts

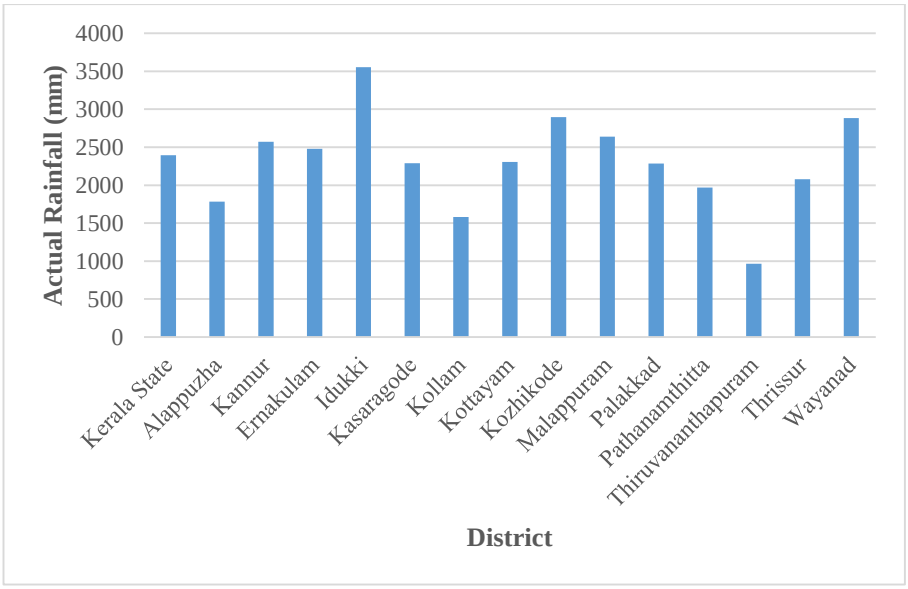

Figure 12: Graph shows the relationship between the Actual rainfall in the monsoon season from various districts

Humanity road launched its crisis desk on August 16 when catastrophic flash flooding and landslides hit Kerala, India. Kerala has seen devastating flash floods and landslides as a result of excessive rainfall. At least 87 people died, over 85,000 had been homeless and Kochi Airport was closed. Many of those killed are said to have been crushed under rubble from landslides. In spectacular images from the region, water was seen flowing down the streets in Kozhikode, Kerala, shutting off road connections and flooding numerous villages. India's Meteorological Department had expected severe to very heavy rain in the state until Saturday and issued a "red alert" for 12 of its 14 districts. Approximately 10,000 kilometers of roads were demolished or damaged along hundreds of dwellings.

Between June 1 and August 18, 2018, Kerala endured the most severe flooding in its history since 1924. During this time, the State got 42% more rainfall than the typical average. The highest rainfall occurred between August 1 and 20, when the State got 771mm. The severe rains caused multiple landslides and prompted the discharge of surplus water from 37 dams around the State, exacerbating the flood situation. Nearly 341 landslides were recorded in ten districts.

According to the State Government's most recent data, 1,259 of 1,664 villages in 14 districts were damaged. The seven most severely affected districts were Alappuzha, Ernakulam, Idukki, Kottayam, Pathanamthitha, Thrissur and Wayanad where the whole district was deemed flood-prone. The devastating floods and landslides affected 5.4 million people, evicted 1.4 million and killed 433 people (May 22-August 29, 2018). Floods and landslides returned to Kerala in 2019. Monsoon season began slowly and late in 2019. The monsoon season was officially announced by the IMD on June 8, 2019. However, rainfall in Kerala was 32% below

average until July 31. Typically, June and July were the 'rainy months' in Kerala. Till July 31, 2019, Wayanad, one of the most impacted districts, had a 55% rainfall deficit compared to the long-period normal (Normal).

However, due to the effect of low-pressure regions and depressions created over the Bay of Bengal, as well as the intensification of Monsoon winds, Kerala State had significant surplus rainfall in August. In August 2019, Kerala experienced 123% more rainfall than the State's long-term average. In August 2018, there was 96% more rainfall than the long-term average rainfall. The most impacted districts in North and Central Kerala were Kozhikode (176%), Wayanad (100%), Malappuram (176%), Palakkad (217%), Thrissur (127%) and Ernakulam (140%), which got more than 100% more rainfall than typical during August. From August 1 to August 31, 2019, 7 of the 14 districts from Kasargode to Thrissur got more than 1000 mm of rainfall. Figure 13 showed that Kozhikode records the highest rainfall at 1407.8 mm, while Thiruvananthapuram registers the lowest at 325 mm, which is significantly lower than most other districts. Other districts i.e Kasargode (1194.5 mm), Wayanad (1190.8 mm) and Kannur (1107.2 mm) also received substantial rainfall, indicating their typical wet climate. Districts like Malappuram (1084.2 mm) and Thrissur (1062.0 mm) fall into the moderate range of rainfall, still receiving a notable amount of rain during the season.

The central districts i.e. Ernakulam (957.7 mm), Alappuzha (676.1 mm), Kottayam (763.0 mm) and Idukki (979.4 mm) showed varying levels of rainfall, with Alappuzha receiving significantly less rain compared to other areas. Pathanamthitta (717.7 mm) and Kollam (549.3 mm) showed slightly lower values, especially Kollam, which registers the second-lowest rainfall. These variations reflected the geographical and climatic differences across Kerala, from coastal regions to hilly terrain.

Table 5
District Wise Departure of Rainfall in 2019

District	Normal Rainfall (mm)	Actual Rainfall (mm)	
Kasargode	658.9	1194.5	81
Kannur	554	1107.2	100
Kozhikode	510.8	1407.8	176
Wayanad	568.3	1190.8	110
Malappuram	392.7	1084.2	1084.2
Thrissur Excess	467.9	1062.0	127
Ernakulam	398.5	957.7	140
Alappuzha	339.1	676.1	99
Kottayam	375.7	763.0	103
Idukki	590.5	979.4	66
Pathanamthitta	333.6	717.7	115
Kollam	258.2	549.3	113
Thiruvananthapuram	144	325	126
State	426.7	951.4	123

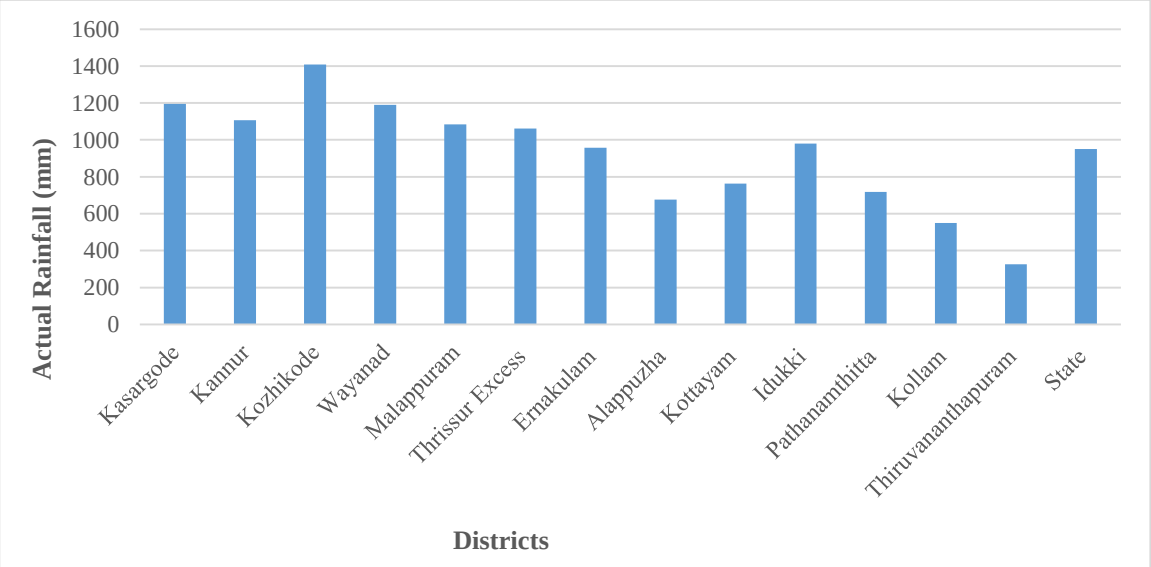

Figure 13: Actual Rainfall analysis in various districts of Kerala in 2019

The overall average for the State denoted as State (951.4 mm), indicated a relatively high level of rainfall, expected during the monsoon season in Kerala. Figure 14 presented corresponds to various regions in Kerala, with values that represent rainfall measurements or similar quantitative metrics. Kasargode recorded the highest figure at 658.9, indicating significant levels compared to other regions. Kannur followed with 554, while Kozhikode and Wayanad showed values of 510.8 and 568.3 respectively. Malappuram had a lower figure of 392.7 and Thrissur, despite being marked as "Excess" records 467.9. Ernakulam and Alappuzha displayed moderate values of 398.5 and 339.1 respectively while Kottayam showed 375.7. Idukki stands out with 590.5, the second-highest value. Pathanamthitta, Kollam and Thiruvananthapuram had relatively lower values of 333.6, 258.2 and 144 respectively.

The overall state value is 426.7, which provides a general idea of the regional trend, with noticeable variability among districts. Landslides occurred in Kerala's Wayanad district on July 30, 2024, due to excessive rains. At the time of the flooding, 392 persons had been verified dead, with another 150 reported missing.

Additionally, there were at least 273 injuries. The incident was noteworthy enough to get its own Wikipedia article, which claimed 570 mm of rainfall in the two days preceding the disaster. The impacted areas included Punjirimattom, Mundakkai, Chooralmala, Attamala, Meppadi and Kunhome, which are tea fields constructed on steep hills. Many of those slain were farmworkers or family members. Obtaining optical satellite photos of the impacted region was particularly difficult during the monsoon time. However, ISRO has published radar photographs of the site as shown in figure 15. Figure 16 shows the situation of Kerala before and after flood.

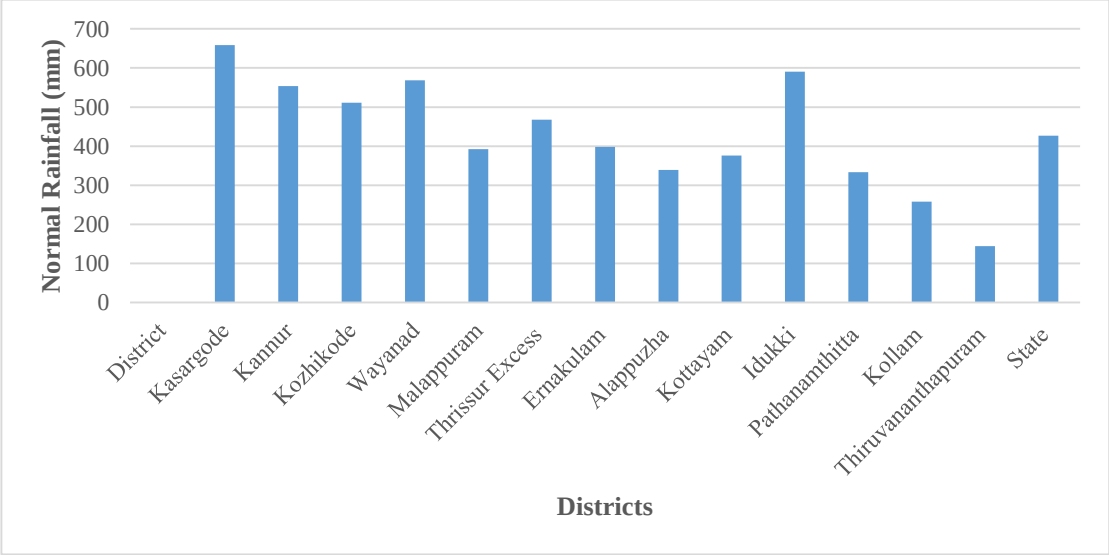

Figure 14: Normal Rainfall analysis in various Districts of Kerala in 2019

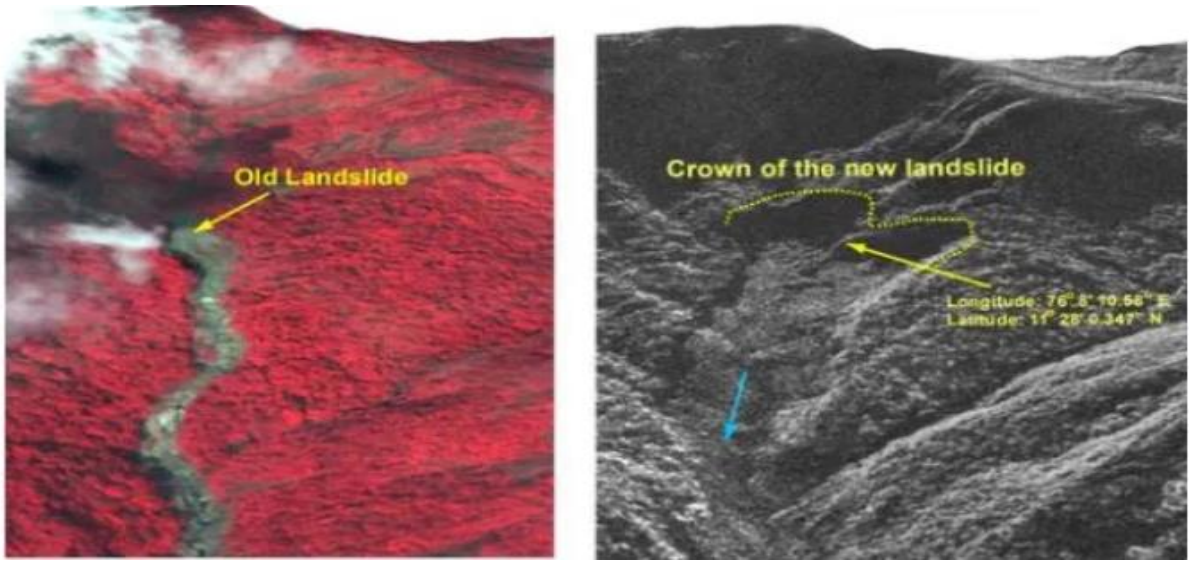

Figure 15: Picture before and after Landslide in Wayanad District, Kerala

Figure 16: Flood picture before and after flood in Kerala

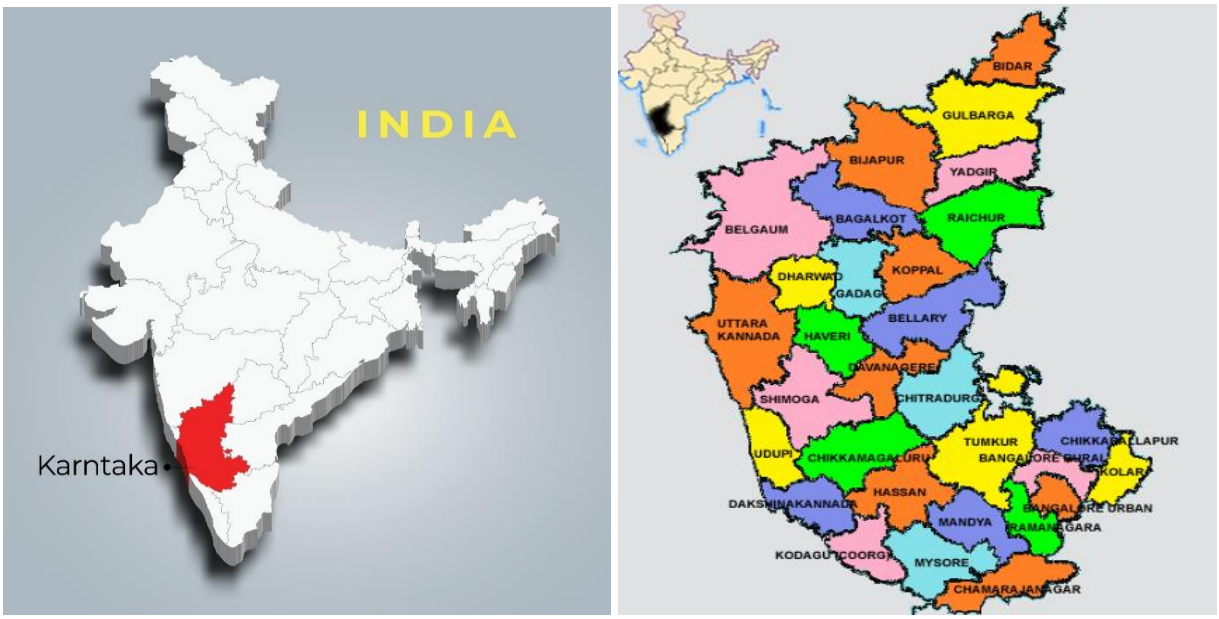

Figure 17: Geographical area of the state of Karnataka

Images taken before July 30, 2024, reveal a protracted runout, a channelized flow that appears to have happened in 2020. The landslide did not reach Mundakkai quietly. According to ISRO imaging, the initial failure for the 30 July 2024 event happened on the same slopes but on a much bigger scale, resulting in a series of channelized debris flows that swept across the towns. According to the ISRO investigation, the landslide covers 86,000 square meters and has an 8-kilometer runout.

Flood in Karnataka (2024)

Karnataka, India's seventh-biggest state, is located between 11° 30' and 18° 30' North latitude and 74° 15' and 78° 30' East longitude. As seen in figure 17, the State is surrounded by Goa in the northwest, Maharashtra in the north, Andhra Pradesh in the east, Tamil Nadu in the south and southeast and Kerala in the southwest. Figure 17 shows the geographical area of the Karnataka State. Karnataka has been dealing with severe rainfall monsoon season, which has caused major damage throughout the State. According to the most recent statistics, 58 people died and 80,000 hectares of crops were destroyed as a result of the "above normal" rainfall.

A total of 13 districts had received higher-than-average rainfall. This year, the northern interior area received 322 mm of rain, up from an average of 260 mm in previous years. Karnataka typically receives 553 mm of rainfall each year, but as of August 12th, the total has risen to 699 mm. Crops on 78,679 hectares and horticulture crops on 2,294 hectares were damaged. In terms of property damage, 1,126 homes had entirely collapsed including 75 unapproved buildings. Additionally, 1,176 houses were severely damaged and 2,338 houses were partially damaged. Overall, approximately 8,000 houses were impacted by the heavy rains. Furthermore, the State had reported the loss of 151 large cattle and 137 small cattle, including cows and buffaloes. Figure 18 shows the flood condition in Karnataka.

Figure 18: Flood picture before and after flood in Karnataka

Main causes of flooding in India

Flooding can occur as a flood of water from water bodies such as a river, lake, or sea, in which the water overtops or destroys levees, causing a part of that water to flow outside of its customary bounds. It might occur as a result of water accumulating on the submerged ground during an airborne flood. Some points on the cause of destruction are as follows:

- Drainage networks in the cities lack proper planning.
- Dying water bodies.
- Lack of waste disposal planning.
- Buildings and construction over the encroached water bodies.
- Climate change resulting in heavy rainfalls.

Each tragedy exposed the framework's flaws and highlighted critical components of the affected network's fragility. As a result, it provides an opportunity to close the gaps and prepare for the next disaster. The sharing of these experiences is critical. Taking the lead from these events and establishing specific steps may help in planning implement, to strengthen flexibility and to avoid fiasco-induced misery, wretchedness and fury.

• Identify flood-prone areas and raise awareness among residents.
• Improved communications for flood-prone regions.
• Stop large-scale mining in such regions immediately.
• Deforestation must be halted in certain regions.
• Tourists must register before entering or exiting the designated regions.
• Provide connectivity facilities, such as roads and footpaths, in these areas.
• Tourist activities should be environmentally friendly.
• Prohibit illegal development in the neighborhood.

The rapid deposition of silt after disasters has increased the vulnerability of low-lying areas near waterways and rivers as shown in 2018, 2019 and 2024.

Conclusion

Along with the current progress in innovation, there is a need to adjust some administrative policies to conserve nature. Water protection guidelines should be used effectively in Uttarakhand, Kerala and Assam to save water in rivers and dams. To meet future needs, it is important to follow standards for preserving normal assets. The unfortunate catastrophic catastrophe in Uttarakhand and other States is the result of a shift in the topography. The public should be conscious of the legislature's new arrangements. The new restoration plans should be implemented while keeping in mind the needs of the United States' large population base.

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