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Dynamic Cyclone Risk in Sri Lanka: Insights from Cyclone Ditwah (2025)

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ABSTRACT

This study investigates the evolving dynamics of cyclone risk in Sri Lanka, with particular emphasis on the impacts of Cyclone Ditwah (2025). Drawing on secondary data sources, published reports, and existing scholarly literature, the research examines the physical drivers, spatial distribution, and socio-economic consequences associated with the event. The analysis reveals a notable shift in cyclone-related hazards in Sri Lanka, where impacts are increasingly driven by extreme rainfall, widespread flooding, and landslides, rather than by wind damage alone. This transition highlights the growing influence of hydro-meteorological factors in shaping disaster outcomes. The study further assesses the level of societal preparedness by evaluating early warning mechanisms, evacuation procedures, and institutional response capacities. While Sri Lanka demonstrates considerable progress in disaster management, particularly in forecasting and emergency coordination, several gaps remain in terms of local-level responsiveness, infrastructure resilience, and community awareness. These limitations contribute to uneven vulnerability across regions and populations. The findings suggest that broader climatic variability, including changing ocean-atmospheric conditions, is contributing to the intensification and unpredictability of cyclone-related risks. In this context, the study underscores the importance of adopting integrated and adaptive disaster risk management approaches that go beyond traditional frameworks. Strengthening multi-hazard preparedness, enhancing community-based resilience, and incorporating climate-informed planning are identified as key priorities for reducing future risks. Overall, the paper contributes to a deeper understanding of how cyclone risk is transforming in Sri Lanka under changing environmental and socio-economic conditions.

1. Introduction

Sri Lanka is an island nation located in the Indian Ocean between the Bay of Bengal and the Arabian Sea, positioned between 5°–10° N latitude and 79°–82° E longitude. This geographical setting exposes the country to periodic influences from tropical cyclones originating in the North Indian Ocean basin [1,2]. Globally, around 80 tropical cyclones form annually, with approximately 7% originating in the North Indian Ocean. This basin is divided into two main cyclone formation regions: the Bay of Bengal and the Arabian Sea. Among these, the Bay of Bengal is recognized as the most active cyclone-prone zone, particularly during the pre-monsoon (April–May) and post-monsoon (October–mid-December) periods. The Intertropical Convergence Zone (ITCZ), where air masses from the Northern and Southern Hemispheres

converge, plays a critical role in cyclone genesis in this region.

Historically, Sri Lanka has experienced limited direct cyclone landfalls compared to neighbouring countries; however, recent events indicate an increasing exposure to extreme hydro-meteorological hazards. Disaster Management Centre [2-3] shows that cyclone activity in the Bay of Bengal is approximately five to six times higher than in the Arabian Sea. More recent assessments highlight that cyclone impacts in Sri Lanka are increasingly associated with secondary hazards such as extreme rainfall, flooding, and landslides rather than wind damage alone.

Several studies have examined cyclone formation, regional climate variability, and disaster impacts in South

Asia; however, most existing research focuses on broader regional patterns or neighbouring countries such as India and Bangladesh. Limited attention has been given to the evolving cyclone risk, specifically in Sri Lanka, particularly in relation to recent high-impact events.

Cyclone Ditwah, which made landfall on 28 November 2025, represents a significant occasion in understanding this shift. The event caused widespread flooding, landslides, infrastructure damage, and socio-economic disruption across the island [4-6]. It highlights the growing complexity of cyclone-related hazards under changing climatic conditions.

The primary objective of this study is to analyze the evolving cyclone risk in Sri Lanka, with special reference to Cyclone Ditwah, and to assess its physical impacts and societal preparedness. Specifically, the study aims to (i) examine the evolving nature of cyclone hazards, (ii) evaluate the effectiveness of early warning and response systems, and (iii) identify key vulnerabilities in disaster risk management.

The scope of this research is limited to cyclone-related hazards affecting Sri Lanka, with emphasis on hydro-meteorological impacts and disaster preparedness. The study is based on secondary data sources and existing literature, without conducting primary field surveys.

Overall, this research is significant in highlighting the transition of cyclone impacts in Sri Lanka from wind-dominated events to complex, rainfall-driven disaster systems, emphasizing the need for improved adaptive disaster risk management strategies.

2. Materials and Methods

This study adopts a non-systematic (narrative) literature review approach to examine theoretical perspectives and empirical evidence on cyclone risk, with particular emphasis on insights from Cyclone Ditwah, 2025 in Sri Lanka. A narrative review was conducted synthesizing diverse and multidisciplinary sources, including peer-reviewed journal articles, books, institutional reports, and credible online databases. The review process began with identifying the research problem and associated knowledge gaps, which guided the scope and direction of the study. An extensive literature search was conducted using major academic databases, including Scopus, Web of Science, and Google Scholar, as well as institutional repositories and reports from relevant national and international organizations. Keywords such as cyclone risk, disaster preparedness, early warning systems, flood risk, landslide risk, and Sri Lanka were used to retrieve relevant studies. All identified sources were screened based on relevance, credibility, and contribution to the research objectives. Priority was given to recent peer-reviewed publications and authoritative institutional

reports. The selected literature was then systematically reviewed, and key information was extracted, focusing on arguments, methodologies, findings, and evidence relevant to cyclone risk and disaster management.

A qualitative synthesis approach was used to analyze the extracted information. This involved comparing and contrasting findings across studies to identify recurring themes, patterns, and inconsistencies. Particular attention was given to issues of vulnerability, preparedness, early warning systems, institutional coordination, and community resilience. This process enabled the identification of key research gaps and emerging trends in cyclone risk. In addition to the literature review, a quantitative analysis of rainfall data was conducted using secondary meteorological data from 24 stations across the island. The stations were; Anuradhapura, Badulla, Bandarawela, Batticaloa, Colombo, Galle, Hambanthota, Jaffna, Monaragala, Katugasthota, Katunayake, Kurunegala, Maha Iluppallama, Mannar, Polonnaruwa, Nuwara Eliya, Pothuvil, Puttalam, Rathmalana, Rathnapura, Trincomalee, Vavuniya, Mattala, and Mullaitivu. Total rainfall per station was calculated to identify the most affected areas, while daily aggregated rainfall values were used to determine peak intensity periods. A time-series analysis was performed to examine the evolution of rainfall intensity during the cyclone event. Furthermore, spatial intensity mapping (heatmap analysis) was applied to visualize the distribution and concentration of extreme rainfall across stations over time. Overall, this integrated methodological approach combines qualitative synthesis and quantitative spatial-temporal analysis, providing a comprehensive understanding of cyclone risk dynamics and impacts in Sri Lanka.

3. Results and Discussion

3.1 Historical Events of Cyclones in Sri Lanka

According to the DMC [2], about 450 cyclones occurred in the Bay of Bengal from 1891 to 2000; of them, about 57% have made landfall in India, 16% in Bangladesh, 8% in Myanmar, 4% in Sri Lanka, while the remaining 15% have dissipated over the ocean. Apart from that, about one-fourth of the above cyclones were very severe with maximum velocity exceeding 118km/h; of them, 52% have made landfall in India, 25% in Bangladesh, 10% in Myanmar, 2% in Sri Lanka, and the remaining 11% have dissipated over the ocean. Accordingly, Sri Lanka has experienced fewer landfalls than the other bordering countries, showing Sri Lanka is less vulnerable to cyclones. Table 1 shows the landfalls of cyclones to Sri Lanka from 1881 to 2000.

Table 1: Landfalls of Cyclones to Sri Lanka from 1881 to 2000

Cyclone No.	Year	Month	Formed in	Landfall
1	1906	January	Bay of Bengal	North
2	1907	March	Bay of Bengal	East
3	1908	December	Bay of Bengal	North
4	1912	December	Bay of Bengal	South
5	1913	December	Bay of Bengal	South East
6	1919	December	Bay of Bengal	North
7	1922	November	Bay of Bengal	East
8	1925	March	Arabian Sea	North West
9	1931	December	Bay of Bengal	North
10	1964	December	Bay of Bengal	East
11	1966	November	Bay of Bengal	East
12	1967	December	Arabian Sea	West
13	1978	November	Bay of Bengal	East
14	1980	December	Bay of Bengal	East
15	1992	December	Bay of Bengal	South East
16	2000	December	Bay of Bengal	East

Source: DMC (2012) Hazard Profile of Sri Lanka

As shown in Table 1, only two of the 16 cyclones have formed in the Arabian Sea, while the other 14 have formed in the Bay of Bengal. Further, 10 cyclones occurred in December, three in November, two in March, and one in January. Accordingly, November and December are more vulnerable to cyclones (See Figure 1). There are no cyclones recorded from April to October, so the high-risk period is November–December.

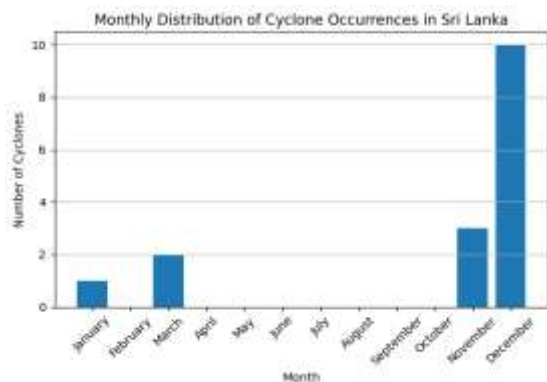


Figure 1: Distribution of Cyclones among months, 1881-2000.
Source: DMC (2012) Hazard Profile of Sri Lanka

Although detailed damage data are not available, the Hazard Profile of Sri Lanka [2] identifies the cyclones of

1964 and 1978 as the most destructive events in Sri Lanka up to 2000.

Considering the landfall locations of cyclones on the island, Figure 2 shows that seven (07) cyclones have fallen in the East, while the Northern region is also significantly exposed (4). Accordingly, the high-risk zones are the Eastern and Northern Provinces. This clearly shows that the eastern coast of Sri Lanka is the most vulnerable to cyclone landfalls.

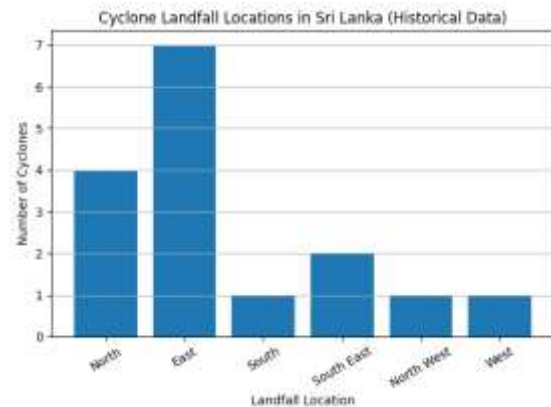


Figure 2: Cyclone landfalls in Sri Lanka, 1881-2000. Source: DMC (2012) Hazard Profile of Sri Lanka

Figure 3 shows the past tracks of storms and cyclones that made landfall in Sri Lanka from 1881 to 2000. As Wijetunge [7] explains, the cyclone that fell in Trincomalee on 23rd December 1964 was reported to have caused 842 human deaths and 100 missing, and the cyclone that fell in Batticaloa on 24th November 1978 was reported to have caused 915 human deaths, while 185,000 housing units were severely damaged and 150,000 partially damaged. The author states that the damage figures given above are due to the combined influence of one or more of cyclone-related effects: high winds, heavy rainfall, and storm surge. Daranagama et al. [8] have also identified that about 33 cyclones have made landfall in Sri Lanka from 1900 to 2020, and they have stated that the 1964 and 1978 cyclones were the most disastrous at that time.

Srisangeerthan et al. [9] showed that Cyclonic Storms (CS) and Severe Cyclonic Storms (SCS) have caused devastating impacts, with some of the most destructive events being SCSs that crossed the country. Even cyclones that were only in the vicinity of Sri Lanka have had significant impacts. 1964 Trinco-Mannar Cyclone was considered the worst in terms of loss of lives, with an estimated death toll of over 1,000, and unofficial estimates reaching over 2,000. It caused widespread destruction, including the Dhanushkodi train disaster due to a 7m storm surge, and maximum sustained winds of 161 km/h in Trincomalee. The 1978 Batticaloa Cyclone event claimed more than 915 lives, injured more than 4,500, and severely damaged over 100,000 buildings. It caused extensive damage to crops, with estimates of

90% loss for coconuts, 70% for perennial crops, and 60% for paddy. The total damage was estimated at 50 million US dollars. Although the 2003 May cyclone did not cross the island, it resulted in torrential downpours and landslides, causing severe damage to infrastructure and 250-300 deaths after stalling in the central Bay of Bengal. This event recorded nearly 360 mm of rainfall in 18 hours in the Ratnapura District.



Figure 3: Past tracks of storms and cyclones, 1881-2000.
Source: DMC (2012) Hazard Profile of Sri Lanka

According to the DMC [10], about 800,225 people were affected by cyclones in 2000, while 476,756 were affected in 1978, and 102,278 were affected by 2020 (Table 2).

Table 2: Human deaths, injuries, house damages, and affected people by cyclones in Sri Lanka, 1978-2022

Year	Deaths	Injured	Missing	Houses Destroyed	Houses Damaged	Affected
1978	834	448	16	6699	23273	476756
1992	6	61	5	1600	15462	92395
2000	6	79	0	9820	71851	800225
2018	0	0	0	89	978	5626
2019	0	0	0	1	10	37
2020	2	6	0	104	3577	102278
2022	0	0	0	7	197	793
Total	848	594	21	18320	115348	1478110

Source: DMC (2026) Disinventar database (Accessed on 10th February, 2026)

Jayasekara et al. [11] compiled a database of cyclone events that occurred in Sri Lanka between 2000 and 2021 (Table 3). According to them, 16 cyclone events have occurred, resulting in 765 human deaths, 31,424 house damages, and 2,531,604 people affected.

Table 3: Damages by Cyclones in Sri Lanka, 2000-2021

Year	Month	Human deaths	Human missing	Affected people	House damage
2000	December	9	-	500,000	480
2003	May	254	-	800,000	24,750
2008	November	15	-	90,000	-
2012	October	10	-	4627	-
2013	May	16	-	-	-
2013	December	5	-	-	-
2016	May	204	-	134,000	-
2016	November	12	-	-	-
2017	May	203	96	588,082	-
2017	November	13	-	200,000	-
2019	April	3	-	5885	1137
2019	October	1	-	20,976	771
2020	May	5	-	2000	500
2020	November	6	-	95,734	3586
2021	May	5	-	48,300	-
2021	May	4	-	42,000	200
Total		765	96	2531604	31424

Source: Jayasekara et al. (2024)

3.2 Impacts of Cyclone Ditwah

The Indian Meteorological Department (IMD) identified and began tracking a depression southwest of Sri Lanka on November 26, 2025 [12]. By 06:00 UTC on November 27, 2025, this system had intensified and was classified as a Cyclonic Storm, named Cyclone Ditwah.

Cyclone Ditwah began impacting Sri Lanka on November 27, 2025. The system intensified and moved in the northeasterly direction, passing over Sri Lanka between November 27 and 29, 2025, before heading into the Bay of Bengal. Figure 4 shows the track of Cyclone Ditwah in the Bay of Bengal [5].

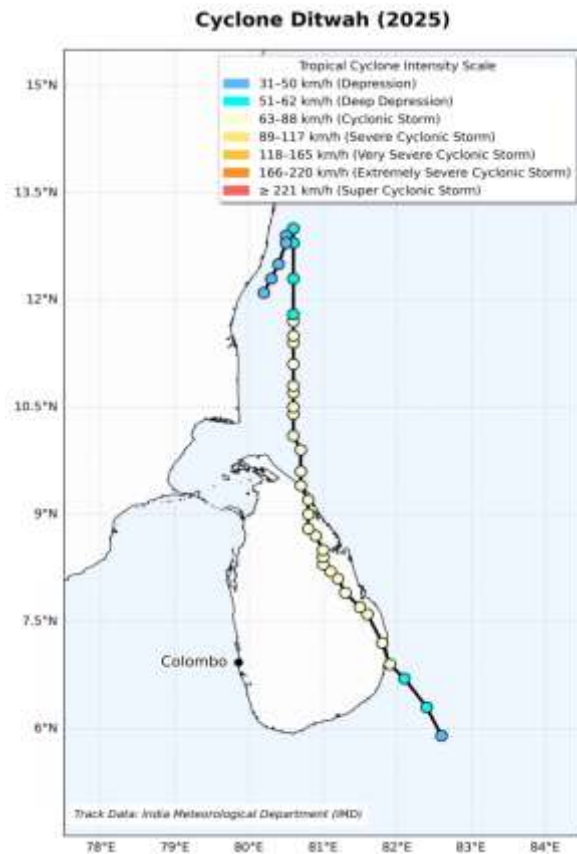


Figure 4: Tracking Cyclone Ditwah (Source: World Bank, 2025)

According to the United Nations Sri Lanka [13-14], the cyclone has resulted in 646 fatalities and left 173 people missing as of December 29, 2025. The UN stated that approximately 1.2 million people were affected by the cyclone, with extensive housing damage, compounding the destruction of nearly 6,000 houses and the partial damage to over 108,000 houses. Cyclone Ditwah triggered the most extensive flooding and landslide damage in Sri Lanka. Geospatial data suggested nearly 20% of Sri Lanka's land was affected by floods. The UN assessment indicated that 95% of surveyed areas reported damage to homes, roads, or critical infrastructure. The nationwide agricultural household survey found that 30% of agricultural households experienced crop damage, with an average paddy production decline of 12%, and the losses were also reported by 53% of vegetable producers and 34% of other field crop producers. Livestock holdings declined among 37% of cattle producers and 63% of poultry producers due to post-flood disease outbreaks. In the fisheries sector, 28% of households reported damage to boats or related infrastructure. Approximately 12.8% of agricultural households experienced moderate to severe food insecurity, with around 75,000 households requiring urgent, targeted recovery support. As per the UN situation report, Cyclone Ditwah caused severe and widespread damage across Sri Lanka, leading to significant loss of life, mass displacement, extensive destruction of homes and infrastructure, and considerable agricultural and

livelihood losses, contributing to widespread food insecurity and urgent recovery needs.

FAO [14], in its impact assessment of Cyclone Ditwah in Sri Lanka, detailed damages across several key agricultural sectors, including crop production, livestock, and fisheries. While specific quantities for all damages are not yet provided, the report quantifies impacts through percentages of affected households, reductions in harvest volumes, or changes in animal populations. Approximately 30% of households reported some level of damage to crop production. Damage to cropland was frequently reported by rainfed, non-paddy producers, particularly in Kandy (affecting 12% of cropland per farmer), Mannar and Jaffna (10% each), and Kilinochchi (7%). A significant decline (50% or more compared to the previous year) in paddy production was observed in North-Central Province (45% of households) and Anuradhapura (46%). Variations by district were substantial, ranging from 0% in Matara to 52% in Hambantota within the Southern Province. About 14% of vegetable producers reported the loss of stored or harvested crops, and 11% of other field crop producers reported crop losses due to flooding, with production estimates lower than the previous year for 62% of them. About 63% of poultry producers and 37% of cattle producers reported having fewer animals than the previous year. Over 80% of households involved in fisheries and aquaculture reported production difficulties, including a reduction in catch or production, regardless of flood exposure. About 28% of fishing households reported damage to equipment and infrastructure, with relatively high average damage values, particularly in aquaculture, approximately USD 2,100.

FAO [15] found that the cyclone's impact on the agricultural sector was severe. Accordingly, the proportion of the agricultural community affected by the cyclone in each district by province is indicated in Figure 5. Accordingly, districts in the Northern and Eastern Provinces have been the most affected; Kilinochchi, Mannar, and Mullaitivu are reported as 100% affected, followed by Trincomalee (99%), Jaffna (97%), and Vavuniya (95%). In contrast, the least affected districts include Galle (17%), Hambantota (20%), Colombo (27%), and Kalutara (29%).

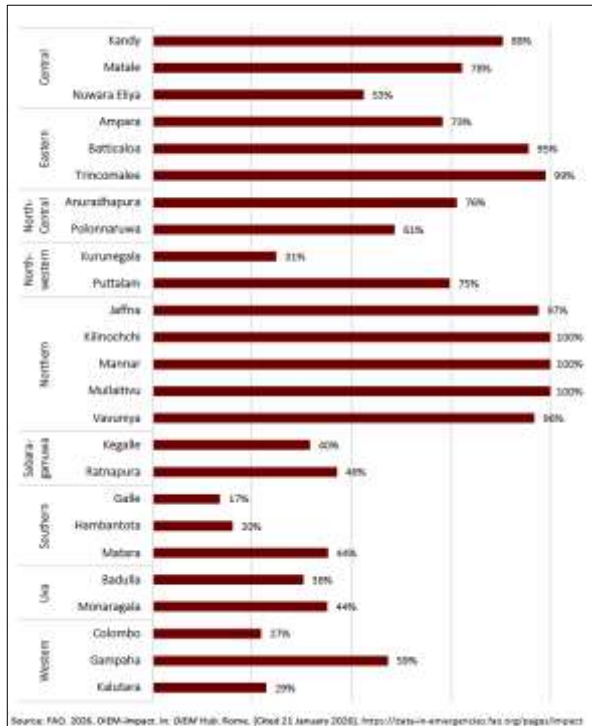
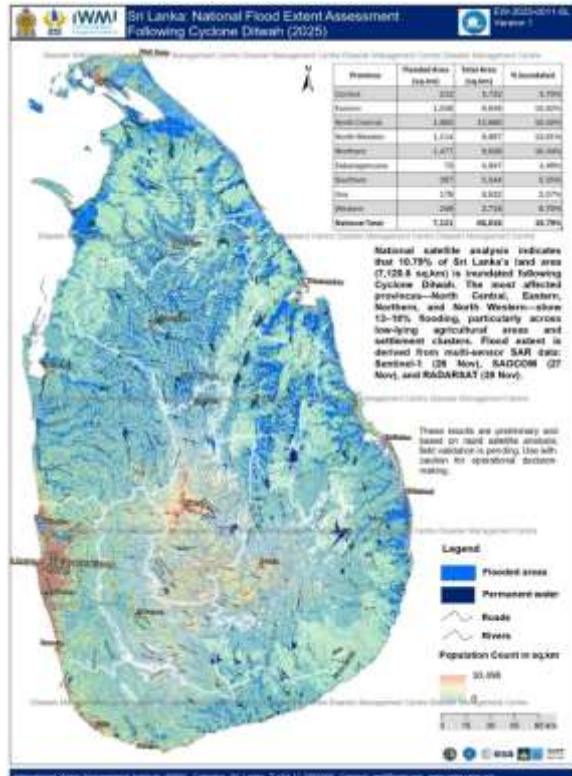


Figure 5: Proportion of the agricultural community affected by the cyclone Ditwah in each district by province. Source: FAO (2026)

The International Organization for Migration [16] conducted an assessment of the damage caused by Cyclone Ditwah in the Kandy district, focusing on housing, infrastructure, and livelihoods. The study, following the Disaster Management Centre's sources, revealed that as of January 25, 2026, 1,933 houses in the Kandy district were fully damaged and 17,350 were partially damaged. The study identified that the Kandy District sustained an estimated USD 689 million in direct physical damages, primarily due to flooding and landslides. Reported impacts to roads, bridges, and water supply networks indicated constraints on service restoration, market access, and repair timelines. According to the report, Kandy District experienced severe and widespread damage from Cyclone Ditwah, particularly to residential structures and agricultural livelihoods, leading to significant displacement and ongoing challenges for the recovery process.

International Water Management Institute & Disaster Management Centre [17] provide a rapid satellite-based analysis of the flooding caused by Cyclone Ditwah (Figure 6). Satellite analysis indicates that 10.79% of Sri Lanka's total land area, approximately 7,120.8 km², was inundated following the cyclone. The flooding was most severe in the following provinces, which saw between 13% and 18% of their land area were under water: In North Central Province, 1,985 km² (18.56%) were under water, while in Northern Province 1,477 km² (16.34%), in Eastern Province 1,536 km² (15.92%), in North Western Province 1,114 km² (13.81%) were under water.



- Climate change has caused substantial damage and increasingly irreversible losses in terrestrial, freshwater, coastal, and marine ecosystems.
- Vulnerability of ecosystems and people to climate change differs substantially among and within regions.
- Adaptation options are available, but there are limits to adaptation, and some limits have already been reached.
- Risks and projected adverse impacts increase with every increment of global warming.

The United Nations Office for Disaster Risk Reduction [20] has revealed that climate change is a significant driver of disaster risk and emphasizes the need for proactive measures to address future hazards, including cyclones and other extreme weather events. It is deemed urgent and critical to anticipate, plan for, and reduce disaster risk to effectively protect people, communities, and countries, thereby strengthening their resilience. This includes preparing for future challenges by focusing on monitoring, assessing, and understanding disaster risk and how it is created. The Sendai Framework for Disaster Risk Reduction [20] applies to the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters caused by natural or man-made hazards, as well as related environmental, technological, and biological hazards and risks. This broad scope inherently covers extreme weather events like cyclones.

The United Nations Framework Convention on Climate Change [21] highlighted in the Paris Agreement that climate change is a critical global threat requiring coordinated action, with an ambitious temperature goal. It addresses the broader implications of climate change through provisions for adaptation, enhancing resilience, and establishing mechanisms to address loss and damage from climate-related events, which would encompass extreme weather phenomena.

Jayawardhana et al. [22] highlight a clear pattern of climate change in Sri Lanka, characterized by rising temperatures and, crucially, an increase in the frequency and intensity of extreme rainfall events. These changes exacerbate climate variability and pose significant threats to various sectors, increasing the risk of hazards like floods and potentially landslides. Trends in extreme precipitation events, such as maximum one-day precipitation, maximum five-day precipitation, and total precipitation on extreme rainfall days, are increasing at most locations. This indicates a rise in the intensity of rainfall. The observed increases in total rainfall are partly attributed to the increase in extreme rainfall events.

World Bank Group & Asian Development Bank [23] explained that Sri Lanka faces significant risks from various climate-related natural hazards, including cyclones, floods, droughts, heatwaves, and landslides.

While the paper notes a regional increase in cyclone intensity, it does not explicitly state that the frequency of cyclones directly impacting Sri Lanka is increasing due to climate change. However, it does highlight the amplified risks posed by climate change to existing hazards. Sri Lanka has a moderate exposure to tropical cyclones and their associated hazards, ranking 45th out of 191 countries in this sub-category according to the INFORM Risk Index. Historically, the majority of cyclones impacting Sri Lanka have occurred between October and December. While the paper indicates that records show a declining trend in cyclone frequency in Sri Lanka over the 20th century, it also reports an increased intensity of tropical cyclone activity in the Bay of Bengal between 1981 and 2010. This regional trend emphasizes the ongoing need for disaster risk reduction efforts. Climate change is expected to influence cyclone hazards in complex ways. Known risks include increased damage from cyclone or storm surges due to sea-level rise, and the possibility of increased wind speed and precipitation intensity. Further research is needed to understand potential changes in cyclone seasonality, routes, and the potential for cyclones to occur in unprecedented locations.

Samaraweera et al. [24] revealed that Sri Lanka is highly vulnerable to the impacts of climate change, which manifests in various natural hazards, including cyclones, floods, and landslides. The country's geographic location, size, and socio-economic conditions contribute to its susceptibility to these climate-induced threats. The authors reviewed that climate change is exacerbating these events, leading to significant socio-economic and environmental consequences. Sri Lanka faces substantial risks from severe and unpredictable weather phenomena such as cyclones, which have led to jeopardized livelihoods, fatalities, and extensive property damage. The influence of climate change on cyclone risks is a complex challenge that remains largely unexplored. Anticipated risks include the amplification of damage from cyclone-induced storm surges due to sea-level rise, along with an increase in wind speed and rainfall intensity. Despite historical data suggesting a decrease in cyclone frequency in Sri Lanka during the twentieth century, research indicates a significant rise in the intensity of tropical cyclone activity in the Bay of Bengal between 1981 and 2010. This trend highlights the critical need for enhanced disaster risk reduction measures. Cyclone 'Roanu' in 2016 brought the highest recorded rainfall in over 18 years, causing extensive flooding across 24 districts and affecting over half a million people. In 2017, Cyclone 'Mora' inflicted severe flooding and landslides across fifteen southern districts. More recently, Tropical Storm "Burevi" hit the northern tip of Sri Lanka in December 2020, leading to widespread flooding.

Srisangeerthan et al. [9] emphasized that Sri Lanka is highly susceptible to severe and unpredictable weather

phenomena, including tropical cyclones, which have historically caused significant damage and loss of life. The paper highlights the increasing intensity of tropical cyclones in the Bay of Bengal region, which has implications for Sri Lanka.

Perera et al. [25] show that climate change leads to more intense and prolonged rain events. The authors argue that the intensification of heavy rainfall due to global warming and it is explained by the Clausius-Clapeyron relationship. Accordingly, climate change increases the likelihood of heavy rainfall associated with Tropical Cyclones (TCs). Factors like TCs, Low-Pressure Systems (LPSs), and monsoon circulations are driven by thermodynamics. Sri Lanka, situated close to the Bay of Bengal, experiences severe natural hazards from TCs. Recent history includes major flood events in 2003, 2010, 2016, and 2017, with Cyclone Ditwah causing catastrophic flooding in 2025. The findings reveal the extreme nature of Cyclone Ditwah in Sri Lanka, comparing it against historical records and climate projections. The key findings highlight the unprecedented magnitude of the rainfall, its impact on established Intensity–Duration–Frequency (IDF) curves, and the implications for flood risk management.

According to Perera et al. [25], rainfall with Cyclone Ditwah significantly surpassed the previously recorded annual high at numerous stations. Stations like Thanthirimale, Kothmale, Randenigala, Dunamale, and Horowpothana recorded rainfall totals well beyond historical variability. Even dry-zone stations, including Horowpothana, Thanthirimale, Yaka Wewa, Manampitiya, and Inginiyagala, experienced unprecedented 1-3-day rainfall, indicating anomalously high rainfall across multiple climatic zones. Over the three days (26–28 November), Sri Lanka received approximately 21.75 ± 1.26 billion cubic meters of rainfall, accounting for 15.8% of the country's Average Annual Rainfall (AAR). This volume is considered unprecedented in the modern observational record. It received more than 8.5 billion cubic meters on both Day one and Day two, which significantly exceeded the rainfall volumes of major flood events in May 2010 (around two billion cubic meters over three days) and May 2016 (over seven billion cubic meters on Day one). This exceptional accumulation explains the widespread flooding, reservoir spillages, and downstream damage. Further, the 2025 November rainfall values lie far above long-term historical records, indicating that the magnitude of the event significantly exceeds the return periods supported by existing observational data. This suggests that the statistical stationarity underlying traditional IDF estimation may no longer be valid under evolving climatic conditions. The consistent and significant separation between historical and updated IDF curves highlights the inadequacy of current design standards in representing the magnitude of emerging rainfall extremes, underscoring the urgent

need to revise infrastructure design criteria and hydrological risk assessments. The authors have further explained that under the Gumbel model, six stations recorded return periods exceeding 1000 years for at least one duration (1-day, 2-day, or 3-day). The Generalized Extreme Value (GEV) model identified seven such stations. Thanthirimale exceeded the 1000-year threshold for all three durations under the Gumbel fit, while Randenigala, Rantembe, Kothmale, and Horowpothana exceeded it for two out of three durations. Extreme return periods exceeding 10,000 years were also observed, with three stations (Thanthirimale, Randenigala, and Rantembe) surpassing this threshold under the Gumbel distribution, and six stations under the GEV distribution. These values, while capped at 10,000 years for analytical stability, indicate that the event is far rarer than anything captured in existing observational datasets. These extreme return periods underscore the extraordinary nature of the November 2025 event, which pushed many hydrological systems beyond their design limits. For instance, major reservoirs like Kothmale experienced inflows well beyond capacity, necessitating emergency spillway releases. In conclusion, the study's results clearly demonstrate that Cyclone Ditwah delivered an extreme rainfall event of unprecedented magnitude, pushing hydrological systems beyond their design limits and necessitating an urgent revision of current design standards and flood risk management strategies to account for an evolving climate.

According to the Department of Meteorology, Sri Lanka [26], the daily rainfall received from 20 to 30 November 2025, during the influence of Cyclone Ditwah, is elaborated below (Figure 7). The data shows a massive surge in rainfall starting from the 24th, reaching its peak on 28th November. On this day alone, the cumulative rainfall recorded in 24 stations across the country was 3,445 mm. The hardest-hit station was Vavuniya, which recorded the highest total rainfall for the period with 823.1 mm, followed by stations in the North-Central and Eastern regions. Anuradhapura (632.3 mm) and Badulla (623.7 mm) also showed significant accumulation, indicating that the cyclone's moisture feed was widespread but particularly concentrated in the northern and central highlands. This chart highlights the geographic distribution of the total rainfall, making it easy to see which stations/districts were most affected. Rainfall Intensity Heatmap (Figure 8) provides a granular view of daily intensity, showing exactly the cumulative rainfall and when each station hit its maximum threshold. Daily Rainfall Trend (Figure 9) illustrates the lifecycle of the cyclone's impact, showing the rapid escalation and the clear peak of the rainfall on the 28th November, 2025 for all stations.



Figure 7: Daily Rainfall Intensity (Source: Developed by the author based on the data of the Department of Meteorology, Sri Lanka, 2025)

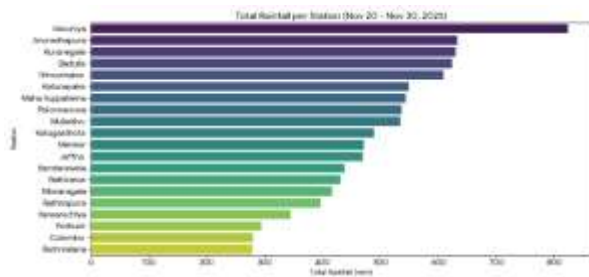


Figure 8: Total Rainfall per station from 20 to 30 November, 2025 (Source: Developed by the author based on the data of the Department of Meteorology, Sri Lanka, 2025)

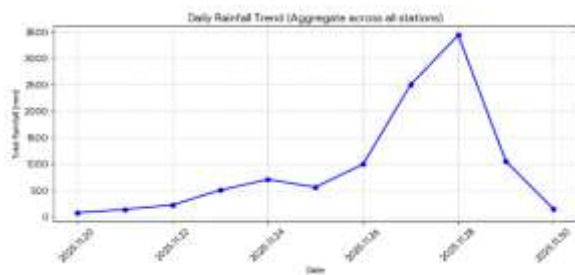


Figure 9: Daily Rainfall Trend (Source: Developed by the author based on the data of the Department of Meteorology, Sri Lanka, 2025)

3.4 Gaps in Current Disaster Preparedness and Response Mechanisms in Sri Lanka

The International Federation of Red Cross and Red Crescent Societies [27] has stated in its situation report that in the aftermath of Cyclone Ditwah in Sri Lanka, the government took several critical steps to manage the disaster response efficiently. Mobilizing security forces to facilitate search and rescue operations and assess the extent of damage, announcing immediate relief packages for the affected that included provisions for household essentials, providing support for rent, and monthly aid, and allocating funds for the reconstruction of damaged houses were among them. These initiatives by the Government of Sri Lanka aimed to address the urgent needs of Cyclone Ditwah victims, providing both immediate relief and support for long-term recovery efforts. While the government has responded to the disaster, many areas remain underserved due to the

widespread and varied needs across affected regions. There were significant gaps in providing temporary shelter for families whose homes were destroyed. Floodwaters have contaminated household wells, increasing the risk of waterborne diseases. Safe drinking water, hygiene items for women and adolescent girls, and cleaning contaminated wells were urgently needed in the aftermath of the disaster. Flood damage to water treatment facilities has increased reliance on unsafe water sources. Many health facilities were damaged or became inaccessible, placing additional pressure on the remaining operational facilities and increasing the risk of waterborne and vector-borne diseases. Immediate first aid, general medical care, and mental health and psychosocial support were urgently required. Displaced populations in crowded safety centers usually face heightened risks of gender-based violence. There was a need for urgent measures, including psychosocial support, violence prevention awareness, and special attention to vulnerable groups like children, pregnant and lactating women, people with disabilities, and those with chronic illnesses. Flooding destroyed school supplies, affecting thousands of students. Essential school items, temporary learning spaces, and psychosocial support for school-aged children are needed to ensure continued education. In conclusion, the IFRC stated that while the response to Cyclone Ditwah has been substantial, particularly through the efforts of the Sri Lanka Red Cross Society (SLRCS) and other helping arms, significant challenges remained in reaching all affected populations, addressing critical needs in shelter, water contamination, health, and protection, and overcoming logistical hurdles posed by geography and seasonal weather. The IFRC report emphasizes the need for continued funding and strategic interventions to build long-term community resilience.

Amaratunga & Kodituwakku [28] studied Sri Lanka's response to Cyclone Ditwah, which highlighted both commendable proactive measures and significant systemic failures in its disaster preparedness framework. While some immediate actions were swift, the sheer scale of the destruction exposed critical gaps that led to a high human and economic toll. The authors highlight the government's prompt activation of emergency protocols in anticipation of Cyclone Ditwah as a positive aspect of preparedness. The Disaster Management Centre (DMC) and the Ministry of Defense took several proactive steps as the storm became imminent. Consequently, the Department of Meteorology issued "Red" alerts 72 hours before landfall, and the DMC activated its emergency response plan, placing the tri-forces on standby for search-and-rescue operations. Over 61,000 people were successfully relocated to nearly 280 safer locations at the peak of the storm. The President declared a nationwide state of public emergency on November 28, 2025, to facilitate rapid resource mobilization.

Additionally, Amaratunga and Kodituwakku [28] found delays in early warning response as a negative aspect and a systemic failure. Despite the initial warning issued in early November, the overall response from relevant officials was less proactive and more reactive. There was a lack of a single authoritative voice in issuing early warning messages, leading to confusion and information overload. Critics noted that emergency warnings were primarily in Sinhala and English, often excluding Tamil-speaking communities in the Central Highlands and North and East. The intense rainfall, reaching up to 500 mm in some areas, caused 46 reservoirs to overflow, which significantly worsened flash floods. Cyclone Ditwah, along with subsequent floods and landslides, exposed deep-seated vulnerabilities within Sri Lanka's disaster management structure, particularly its capacity to handle large-scale, multi-systemic disasters. Most of Sri Lanka's existing drainage and reservoir systems are designed for 1-in-50 or 1-in-100-year events, making them insufficient for a 1-in-200-year cyclone, which can be 28% to 160% more intense than typical monsoon extremes due to climate trends. Persons with disabilities (PwDs) were among the least warned, with a majority receiving no early warnings due to deep-seated systemic gaps in communication, such as the absence of sign language interpretation and accessible communication devices. Systemic gaps in disaster response meant PwDs lacked safe evacuation options. All 368 established evacuation centers were inaccessible, lacking ramps, accessible toilets, and privacy in washing areas. Accordingly, authors have highlighted that, while Sri Lanka demonstrated some capacity for immediate disaster response through early warnings and evacuations, Cyclone Ditwah revealed deep weaknesses in inclusive communication, outdated infrastructure design, and fragmented early warning systems, necessitating a comprehensive overhaul to build true resilience against future extreme weather events.

Ability for Action et al. [1] detailed the impacts of Cyclone Ditwah on persons with disabilities (PwDs) in Sri Lanka, a population segment that constitutes about 8.7% of the country's population. The rapid assessment report details the severe and disproportionate impact of Cyclone Ditwah on PwDs in Sri Lanka, highlighting systemic failures in disaster preparedness and response. The findings describe that PwDs were among the most exposed, least warned, and least served during and after the cyclone. The majority of PwDs across the four assessed provinces (Uva, Central, Northern, and Western) received no early warning before the cyclone struck. Specifically, 100% of respondents in Uva Province, and nearly 80% in Central, Northern, and Western provinces, did not receive warnings. The failure to warn PwDs was not an exception but a reflection of deep-seated systemic gaps in inclusive communication within national disaster risk reduction frameworks. Barriers included the absence of sign language

interpretation, the lack of accessible communication devices such as TVs, radios, and smartphones due to poverty, and power outages. When early warning systems failed, PwDs could not evacuate safely due to systemic gaps in disaster response. The report emphasizes that Cyclone Ditwah did not merely cause damage but exposed and deepened pre-existing vulnerabilities and systemic exclusions faced by PwDs in Sri Lanka, stressing the urgent need for disability-inclusive disaster preparedness and response mechanisms.

Wanninayake et al. [29] examined the functionality of flood preparedness in the Deduru Oya Basin in Sri Lanka. The authors identified several strong aspects of preparedness; among them, the functioning of the flood early warning system was a key component. Approximately 85% of respondents confirmed the presence of such a system, and about 52% were satisfied with receiving the warnings. There is a high level of consensus (98%) among the public regarding the importance of implementing a flood early warning system as a preparedness measure. Despite some shortcomings, the area has a mechanism to disseminate flood early warnings to the last mile, and most people are satisfied with the prevailing system. Along with this, a significant strength identified was the ability of people to evacuate. About 93% of the respondents stated they are satisfied with their ability to evacuate to safer places during flood emergencies. However, the authors identified several gaps in preparedness. A major weakness is the lack of regular training and awareness programs; about 87% of respondents indicated that such programs are not conducted regularly in the study area, while 96% agreed on the need for training. Village-level Disaster Management Committees (VDMCs) and Village Level Disaster Management Plans (VDMPs) are nonexistent or operate ineffectively. All respondents (100%) stated that VDMCs are not operating, and 99% mentioned that no VDMPs have been prepared in the area. The development of flood hazard maps is severely lacking, with 97% of respondents noting their absence. Land Use Planning (LUP) and Building Codes (BC) are crucial in flood risk management, but these tools are not operating in the area. Most lands in inundation areas are encroached for housing and cultivation, making them vulnerable. Market-based instruments such as Flood Risk Insurance, Local Emergency Funds, and Mitigation/Reconstruction Loans for flood risk reduction are not operating in the area. About 99% of respondents indicated the absence of the above schemes. People's Rebuilding Capacity after a flood is unsatisfactory, with about 90% of respondents expressing dissatisfaction with their capacity to rebuild. Similarly, public involvement in flood risk management activities is inadequate, with 61% of respondents expressing dissatisfaction. The current communication and coordination mechanisms for flood risk management are unsatisfactory, with 59% of

respondents reporting dissatisfaction. The involvement of government agencies in flood risk management activities is also deemed unsatisfactory, with 69% of respondents expressing this view. According to the authors, while Sri Lanka has a functional flood early warning system and satisfactory evacuation capacity in the study area, there are significant deficiencies across almost all other preparedness measures. These include a lack of community-level structures, inadequate planning tools such as hazard maps and land-use plans, absent financial support mechanisms, and unsatisfactory levels of public participation, communication, and government involvement. This malfunction of preparedness measures contributes to the low capacity of vulnerable people in the region.

Wanninayake et al. [30] revealed that stakeholders play a crucial role in local-level flood risk management, with various entities engaged in different capacities. However, the study highlights significant gaps and inefficiencies in their overall involvement and coordination. The Irrigation Department (ID) is responsible for issuing flood early warnings, while the local-level subcommittees, such as the early warning dissemination subcommittee, are also tasked with this function. Most people receive flood early warnings through the existing system, with 84.5% of respondents confirming its presence. The ID is recognized as a responsible agency for establishing a database of flood information, identifying flood patterns, mapping inundation areas, and modelling flood simulations. The Department of Meteorology is responsible for forecasting rainfall and adverse weather conditions, and the Land Use Policy Planning Department (LUPPD) for preparing general land use plans. However, local-level flood hazard maps have not been prepared, and comprehensive flood risk assessments for the community level are lacking. The National Disaster Management Plan (NDMP) [31] assigns responsibility for identifying disaster mitigation projects and preparing mitigation plans to Provincial Councils (PC), Local Authorities (LA), and public/private sector organizations. District, Divisional, and Grama Niladhari (GN) level administrations are also expected to develop and coordinate mitigation plans. However, mitigation plans for flood risk management have not been prepared by local-level institutions in the study area, with existing plans primarily addressing the response phase. Subcommittees for evacuation, search and rescue, relief camps, food and security, and immediate restoration of services are outlined in Divisional Disaster Response Plans (DDRPs). While responsibilities for evacuation are reported, organized committees for these functions are not operating in the study area. Local governments have resources but limited involvement in flood risk management due to a lack of legislative power. Roles and responsibilities of stakeholders are often not clearly defined in existing flood ordinances, and agencies often lack the legal power to take judicial actions against

disaster-induced activities. There are also issues with coordination between the "National Administration Line" and "Local Administration Line," which operate independently. As per the authors, in conclusion, while a comprehensive framework for stakeholder engagement in local-level flood risk management exists on paper, its implementation is significantly hampered by undefined roles, lack of legal mandate, insufficient training and awareness, and poor coordination among various entities. This leads to minimal satisfaction among the affected population regarding government involvement in flood risk management activities.

4. Conclusion

This study demonstrates that cyclone risk in Sri Lanka is increasingly characterized by rainfall-driven hazards, particularly flooding and landslides, rather than wind impacts alone. Cyclone Ditwah, 2025, illustrates this shift, highlighting the growing influence of hydro-meteorological extremes on disaster outcomes. While notable progress has been made in early warning systems, forecasting accuracy, and evacuation capacity, persistent challenges remain in infrastructure resilience, land-use planning, and inter-agency coordination. In addition, localized vulnerabilities and uneven community preparedness continue to exacerbate risk in highly exposed regions. Addressing these gaps requires a more integrated, multi-hazard approach to disaster risk management that incorporates climate projections, strengthens institutional collaboration, and prioritizes community-based resilience. Such measures are essential for minimizing future losses and enhancing Sri Lanka's adaptive capacity in the face of intensifying climate variability.

5. Recommendations

1. Strengthen early warning systems with improved accuracy and localized communication.
2. Enhance community-based disaster preparedness and evacuation planning.
3. Invest in resilient infrastructure to withstand flooding and landslides.
4. Integrate climate change projections into disaster risk management policies.
5. Improve coordination among government agencies and stakeholders.
6. Promote land-use planning practices that reduce exposure to hazard-prone areas.

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