

Is resilience socially emerging or embedded?: A review of “resilience” under climate change in Sri Lanka

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ABSTRACT

Since the advent of a new academic regime that examines the nexus of humans and water, resilience studies of the coevolution of human–water systems have advanced rapidly because of the climate change. However, the concept of resilience poses a new social challenge. This study analyzes the gap in resilience studies through a Sri Lankan water-related disaster research review. Moreover, the authors discuss the potential and challenges for resilience evolution under climate change in Sri Lanka. Analyzing the nuance of resilience, the review showed that resilience is complementarily emerging and embedded in culture and society, such as traditional knowledge and local history, and from scientific research-oriented translation and wide international policy view in both. Resilience is the accumulation of stable states and supporting mechanisms found in the interaction between normal phases and emergencies in elements unique to the region. This study suggests that it is critical to support the resilience and mechanisms of the whole and each layer, leveraging the diverse and sustainable livelihoods in the Sri Lankan context against climate change.

1. Background

The world is gradually becoming increasingly unfamiliar to us because of climate change. Absorbing and mitigating the impact of water-related disasters, countries, locals, and communities are confronted with challenges in building and maintaining resilience, as depicted in various studies [1, 2]. The main drivers of social vulnerability to floods and landslides are socioeconomic conditions, land tenure, demographics, health, coping capacity, neighborhood characteristics, and risk perception [3]. Recently, the extreme 2016 and 2017 floods in Sri Lanka highlighted the vulnerability of modern infrastructure to large-scale water-related events such as cyclones, monsoonal rain, and subsequent flooding and landslides [4,5]. Localized and seasonal flooding and landslides are forming the greatest threat to the population, and the flood risk profile is rising because of the expected increase in the impact and frequency of hydro-meteorological hazards [6]. The situation was even worse than expected, as Sri Lanka was among the three most affected countries in the 2017 estimate of weather-related loss events, ranking second highest on the Climate Risk Index, which measures fatalities and economic losses caused by extreme weather [7]. Unusual events such as the 2017 flooding following a strong monsoon contribute to the risk status, as the event caused over 200 fatalities and displaced over 600,000 people across 12 districts [7]. Economic losses following the 2017 flooding increased by 50% compared to the period between 2007 and 2016 [8].

Social instability creates tensions in how Earth System science imagines and tackles its policy challenges and sustainability [9,10]. On the one hand, the ecological concept of resilience has been translated into a social orientation toward emergence and collective learning, manifesting in proposals for adaptive environmental governance [10–15]. Research in technologically developed nations demonstrates that effective flood and landslide management must involve a well-conceived public policy and consideration of individual perceptions and behaviors [17]. Since the advent of a new science examining humans and water, resilience studies of the coevolution of human–water systems and society have been rapidly advancing because of climate change [18,19]. In this context, the concept of resilience is useful in materializing the way to think about and challenge the ongoing production and reproduction of hazard scape in Sri Lanka [20,21]. Increasing attention is now focused on the capacity of disaster-affected communities to “bounce back” or recover with little or no external assistance following a disaster. This highlights the necessity for a change in disaster risk reduction, with the stronger emphasis being placed on resilience rather than need or vulnerability [22,23]. However, varied conceptualizations of resilience pose new social challenges and have their core characteristics. For example, rather than perceiving technological development as a way for people to reduce their vulnerability, resilience evaluates the sustainability of adaptation technology from an ecological perspective. Further, focus on resilience is not considered in the light of specific activities or changes,

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but rather how various activities and changes feedback either positively or negatively into the system over time. This shifts the focus away from taking a particular action to increase adaptation against a single hazard and considers climate change, along with other disturbances, as an opportunity to strengthen socioecological systems. This is a more effective means of holistic and proactive risk management than approaches that focus mainly on reducing vulnerability or mitigating climate change [20]. Furthermore, few studies have focused on and critically reviewed the concept of “resilience” in Sri Lanka in climate change and disaster contexts. Thus, the research questions are as follows: (1) How do the nation and the United Nations formulate action and policy for disaster risk management and reduction and climate change to create the concept of resilience in Sri Lanka? (2) What are the hazards, exposures, and vulnerabilities of climate change in Sri Lanka? (3) How has the resilience concept emerged or become socially embedded in the Sri Lankan context? (4) How are the researchers addressing the overarching goals for creating a resilient society in Sri Lanka?

Accordingly, this study clarifies the context of resilience and articulates the gap in resilience through a review of Sri Lankan water-related disaster research under climate change. Resilience is socially constructed or is strongly influenced by social and individual self-perception, norms, values, and self-confidence in people’s ability to handle future events [24]. However, it is critical to expand resilience analysis beyond a descriptive analysis of the frequency and severity of unexpected shocks or the types of responses adopted within socioeconomic groups in specific contexts. The result would be a more nuanced analysis of the individual and collective processes that mediate people’s ability to respond and adapt to such shocks [24]. Further, a comprehensive social resilience framework created by the nation, UN, and researchers, which can be adapted to different contexts and integrated with specific measurement tools and guidelines, is necessary [25]. While recurrent and extreme weather-related disasters have occurred in Sri Lanka, resilience has reframed the flood and landslide risk management system as an integrated and adaptive system, recognizing of the uncertainties caused by the dynamics of socio-spatial interdependencies of flood risk [26]. Therefore, resilience integration has become a crucial aspect of operationalizing flood and landslide disaster resilience, governed by the adaptive capacities and strategies in the knowledge base of the dominant discourses of stakeholders as well as the way of power and the resources expended in the context. The nuances of resilience must be examined because there is a need to identify the concept of how “resilience” is contextualized in modern Sri Lankan society in the context of active climate change and recurrent disasters.

2. Overviewing the national action and policy for managing disaster risk and climate change in Sri Lanka

2.1. Public policy and national action for managing disaster risk and climate change in Sri Lanka

Public policy, which embraces problem-solving-oriented actions for social common goods and attempts to solve problems by people and for people, is the concern of governments and targets community challenges through overarching approaches and collaborations that can overcome communities different boundaries for the sake of a shared future [1]. In Sri Lanka, the Disaster Management Act was established and enacted in 2005 because of the destructive impact of the Indian Ocean tsunami in 2004 [8,27]. The purpose of this act was to mandate the establishment of the National Disaster Management Center and the Disaster Management Center (DMC) and enhance disaster operations by coordinating stakeholders and localizing of operations for nations, provinces, and districts [28,29]. However, gaps exist in the Sri Lankan local government sector after the devastating Indian Ocean tsunami institutionalized disaster risk reduction (DRR). Even after ten years, local governments are still struggling to overcome several challenges related to resilience in the built environment. DRR has not yet been properly integrated into the

local government system and, consequently, poses a significant challenge [30–32]. In addition, the Government of Sri Lanka launched a national initiative to address the impacts of climate change. The Climate Change Secretariat of the Ministry of Mahaweli Development and Environment plays a leadership role in this activity—the National Focal Point for the United Nations Framework Convention on Climate Change, which spearheads the process. Among the key national initiatives, the National Climate Change Adaptation Strategy for Sri Lanka 2011–2016 prepared in 2010 and the National Climate Change Policy adopted in 2012 are the two major achievements [33].

The concept of resilience has been increasingly discussed in disaster studies, particularly since the adoption of the Sendai Framework for Disaster Risk Reduction 2015–2030 [34]. Experiences in preparing for and responding to disasters have necessitated a growing and urgent emphasis on the development of effective methods to measure disaster resilience so that timely investments in resilience-building can be implemented to prevent and mitigate future disaster losses and damage. The Sendai Framework for Disaster Risk Reduction 2015–2030 established “Investing in Disaster Risk Reduction for Resilience” as Priority Action 3 with 17 actions at national and local levels and nine actions at global and regional levels. However, to date, the budgets for DRR have been mainly used for post-disaster emergency response, recovery, and reconstruction in many countries [35].

It was proposed to identify mechanisms to integrate the Sendai Framework into the Sri Lankan National Disaster Management Framework. However, during recent disasters, the DMC and disaster management framework were severely criticized by the public as well as the technical community [29]. While development plans identify the needs and priorities of communities, the intent behind formulating development plans is to empower communities. DRR and climate change adaptation integrated development strategies will enable state and non-state stakeholders to implement risk-informed actions in disaster-prone areas. The formulation of risk-sensitive village and regional development plans has been promoted in the recent Community Resilience Framework (CRF) of Sri Lanka [36]. Sri Lanka’s CRF aims to guide this process from both directions—a bottom-up hierarchical approach from the community to the sub-national level and a top-down policy implementation approach from the national state mechanisms to sub-national levels. Operationalizing the CRF by implementing risk-sensitive development actions begins with better planning at the national level and the community and local government levels [37]. Moreover, some studies identified seven challenges that hinder multi-agency collaboration—communication, environmental, social, political, inter-organizational, intra-organizational, and infrastructure challenges—and corresponding strategies that can overcome them. Communication was considered the dominant challenge owing to the lack of a technology platform and well-defined guidelines for sharing data among the agencies to establish a common view of the disaster context [38]. In addition to the DMC, private television and radio organizations use SMS to inform the public about disasters. Further, quick and constant updates on forthcoming disasters are also provided through television and radio as “Breaking News,” and emergency warnings and updates on disasters are distributed via social media such as Facebook and Twitter. However, social media use is limited to people living in urban areas and the working community of Sri Lanka. Those in rural areas and those who engage in agriculture work rarely use social media [39].

The DMC in Sri Lanka has formalized a multi-stakeholder DRM framework, although that initiative has not yet been completely assessed theoretically or practically, and the resilience concept has hardly filled the gap. This indicates that resilience studies should focus more on how the structural components (nodes and links) are arranged over time and how various network characteristics such as connectivity and centrality operate in dynamic situations [40]. As the main governing policy for the DMC and DRR in Sri Lanka is the Sri Lanka National Disaster Management Policy, the effectiveness and efficiency of the policy were investigated. In addition, alignment with comprehensive global frameworks,

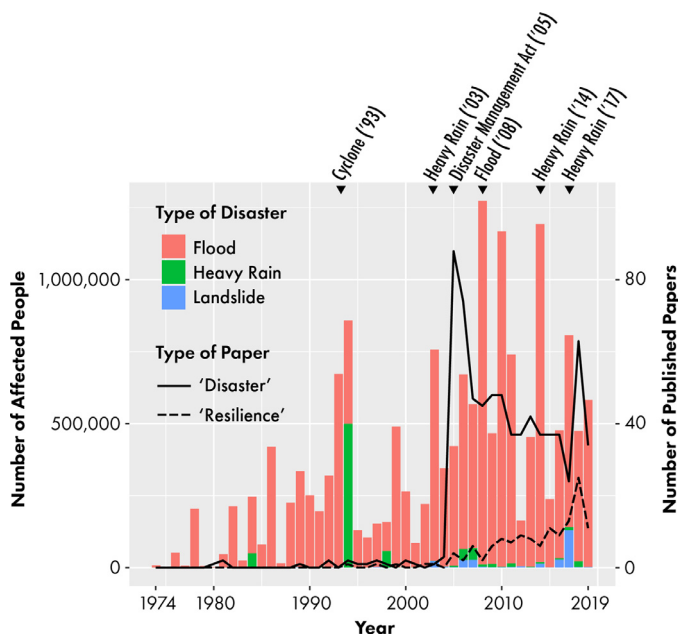


Fig. 1. The relationship between the number of published papers and the number of affected people in Sri Lanka.

such as the Sendai Principles, was checked to identify its alignment with global standards. The Sri Lanka National Disaster Management Policy was evaluated against seven criteria, identified after carefully analyzing the Sendai Framework requirements [29].

2.2. The discovery of the concept of resilience in Sri Lanka

To illustrate the impact of the public policy on resilience research in Sri Lanka, the authors created Fig. 1, which shows the relationship between the number of people affected by water disasters and the number of papers published in Sri Lanka in the period 1974–2019. The number of affected people was collected from Desinventar, a website published by the United Nations Office for Disaster Risk Reduction (UNDRR), an open-source disaster information management system. From Desinventar, the authors extracted the number of people indirectly affected by floods, heavy rains, and landslides, which had the fewest data deficiencies. The number of published papers is based on Scopus, a literature database provided by Elsevier. To examine how the number of papers changed over time, the authors extracted the numbers of hits for English peer-reviewed journal articles based on search queries "Sri Lanka" AND "disaster" and "Sri Lanka" AND "resilience" for the title, keyword, and abstract.

This figure immediately shows two noteworthy points. First, the number of papers on "disaster" increased sharply in 2005. This is an interesting phenomenon, considering that no sharp increase can be observed in the number of affected people or the number of resilience-related studies. Upon inspection, the authors found that this sharp increase in disaster-related studies coincided with the introduction of the Disaster Management Act in 2005. This implies that it is likely that researchers were made aware of disaster-related issues in Sri Lanka almost immediately after the introduction of this public policy.

On the other hand, such abrupt increase cannot be observed for resilient-related studies. The number of papers on "resilience" has been on a steady but slow rise since around 2015. This gradual increase in resilience-related studies can be tied to a global trend that had a significant impact on raising awareness of disaster resilience in Sri Lanka, including the Sri Lanka Community Resilience Framework issued by the Ministry of Disaster Management of Sri Lanka in 2015. This framework was one of the consequences of the Sendai Framework for Disaster Risk

Reduction 2015–2030, issued by the UNDRR in 2015. Fig. 1 illustrates an interesting phenomenon: the number of resilience-related papers increased as Sri Lanka received more international attention partly because of the increase in disasters but also because the legislation. In other words, Fig. 1 shows the process of the "discovery of the concept of resilience" through translation in Sri Lanka.

3. Hazards, exposure, and vulnerability under climate change in Sri Lanka

The potential loss of life, injury, or destroyed or damaged assets that could occur in a system, society, or a community at a specific time are determined probabilistically as a hazard function, exposure, or vulnerability. According to UNDRR Terminology [41], disasters are a "serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability, and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts." The UNDRR defines disaster risk as the probabilistic determination of potential loss or damage to a society, community, or system in a specific time period. Therefore, effective disaster risk assessment depends on the understanding of such hazardous events and conditions of exposure, vulnerability, and capacity. In this section, we consider the hazards, exposures, and vulnerabilities under climate change in Sri Lanka based on significant prior previous studies. Table 1.1 is designed with the conceptual framework expressed in each risk assessment or management method—specifically risk, hazard, exposure, and vulnerability concepts and their barriers and application to the specific natural hazard under examination in the list of keywords.

3.1. Hazards

The most common hazards in Sri Lanka are seasonal and localized flooding and landslides across the country, followed by cyclones, storm surges, droughts, and high winds. The Disaster Management Act of 2005 recognizes 21 natural and anthropogenic hazards, ranging from cyclones (16 of which have made landfall in the last 130 years), earthquakes, fires, and epidemics to radiological emergencies, nuclear disasters, and coastal erosion. However, because of the diverse topography and environment, the occurrence of disasters varies significantly. Notably, during the last decade, the occurrence of natural hazards has increased by 22 times, mainly caused by an increased impact of hydro-meteorological events [28].

Sri Lanka has two distinct monsoon seasons, usually followed by flooding and landslides caused by extreme rainfall. These seasons exhibited a significant spatial variability. The southwest monsoon in May–September affects the southern and Sabaragamuwa provinces the most; during the northeast monsoon in December–February, eastern, northern, and north-central provinces are most prone to flooding and landslides. To detect the disaster risk, a disaster inventory map, disaster vulnerability map, disaster risk map, and early warning system were produced to understand the disaster and the risks associated with GIS technology [42,43]. Several local measures, such as infrastructural interventions, have been proposed to address this problem. To quantify the expected reduction in future flood damage resulting from the proposed measures and compare the risk reduction to the proposed measure costs, Wageenaar et al. created probabilistic inundation depth maps using a hydrodynamic model. A detailed flood damage model and socioeconomic development scenarios were then applied to estimate the damage with and without the measures [44]. Landslides have a significant impact on community income sources and households, and higher costs are incurred for subsequent rehabilitation and ongoing maintenance. Furthermore, the severity of the impact on household income is highly dependent on the affected land size [45]. Landslides brought social impacts as consequences to human populations of any landslide incident that alters how people live, work, spend their leisure time, relate to one another,

Table 1
Overview of hazards, exposure, and vulnerability under climate change in Sri Lanka.

Scope	Keywords	Previous Research
Hazard	GIS, probabilistic inundation depth maps, impact on household income, social impacts	K. V. D. Edirisooriya, N. S. Vitanage, P. Uluwaduge, and E. M. T. K. Senevirathna, [42], S. S. L. Hettiarachchi and S. Weerasinghe [43], D. J. Wagenaar et al. [44], E. N. C. Perera, D. T. Jayawardana, P. Jayasinghe, R. M. S. Bandara, and N. Alahakoon [45], C. K. M. Deheragoda [46]
Exposure	influence of anthropogenic activities, economic exposure, social factor which influence the decision to live in a high-risk area, inadequacy of land, climate change and the development activities in river catchments, legal land ownership, long-term economic well-being, disaster insurance, establishment of human settlements, change in land use pattern, relocation project	L. Manawadu and V. P. I. S. Wijeratne [47], K. M. Weerasinghe et al. [48], J. Askman, O. Nilsson, and P. Becker [49], P. Dissanayake, S. Hettiarachchi, and C. Siriwardana [50], V. Hewawasam and K. Matsui [51], K. Wickramasinghe [52], P. Jayasingha [53], M. Mendis [54], N. Fernando et al. [55]
Vulnerability	socioeconomic issue, understanding of climate transition, gender contexts, women empowerment, poverty, sole livelihoods, migration, informal settlements, project specific guidelines, agriculture, adaptive capacity, inaccessibility, unequal distribution of aid, lack of infrastructure and transport facilities, regional disparity	Ministry of National Polices and Economic Affairs and Ministry of Disaster Management [4], Ministry of Disaster Management and Ministry of National Policy and Economic Affairs [5], R. R. Churchill and D. M. Hutchinson [16], K. Wickramasinghe [51], T. Hewawasam [56], J. Prasanna and W. Gnanatheepan [57], M. Esham and C. Garforth [58], S. Weerasekara et al. [59], G. Samantha [60], K. Hemachandra, D. Amaratunga, and R. Haigh [61], K. De Silva and R. Jayathilaka [62], M. Friedrich [63], N. Fernando [64], M. M. G. T. De Silva and A. Kawasaki [65, 66], Central Bank of Sri Lanka [67], U. S. Thathsarani and L. H. P. Gunaratne [68], S. Keerthirathne and R. S. J. Tol [69], A. Y. Karunaratne and G. Lee [70]

organize to meet their needs, and generally cope as members of society. These included changes in cultural norms, values, and beliefs that guided and rationalized their cognition of themselves and their society [46].

3.2. Exposure

Exposure can be considered as people and assets that can be affected by the disasters, and policies such as land use regulations and relocation from hazardous areas can be considered countermeasures. In the exposure context in Sri Lanka, anthropogenic activities in the area influence the severity of recent flood events. Owing to suburbanization by conversion of paddies and wetlands into home gardens from 1972 to 2018, the decreasing trend of marshy lands, home gardens, and paddy lands occurred because of the population pressure generated from the commercial city [47]. The flood risk to the population is more sensitive to economic exposure than to social exposure, and the type of housing unit is a reasonable indicator for assessing the risk to housing [48]. Some case studies have identified and explored the underlying social factors, such as risk normalization, risk trade-offs, and push-and-pull processes, which seem to influence the decision to live in a high-risk area [49]. The lower sector of urban society has no alternative but to settle in informal settlements in vulnerable areas, such as flood plains or canal banks because of poverty and the inadequacy of land in cities. Therefore, the urban poor are more exposed to disasters.

Furthermore, some areas that were not vulnerable to disasters in the past have become vulnerable owing to climate change and development activities in river catchments [50]. The intensity and frequency of rainfall increased in the area, but the residents did not receive any flood protection support from the government because of legal and socio-political complications [17]. Many expressed their fear of the next flood incident. As these residents were without legal land ownership, the government did not pay much attention to their needs [51]. All disaster-related socioeconomic measures in place are highly skewed toward immediate relief, whereas the long-term economic well-being of the disaster-vulnerable groups has received minor attention [52]. Disaster insurance schemes are also not properly developed, and the existing crop insurance schemes show low coverage. The increasing population growth trend in Sri Lanka has adversely affected the stability of central highlands because of various human activities. Among them, the establishment of human settlements and changes in land-use patterns have become critical issues in triggering land instabilities in the central highlands of the country [53].

The severity of the impact prediction of a disaster is strongly depends on the level of hazard risk. Areas with a smaller number of hazards do

not always necessarily result in the lowest hazard risk because the areas have different levels of exposure. Most flooding in Sri Lanka occurs when heavy rain falls in the upper catchments of the major river basins. This allows the warning authorities a long lead time to estimate the likelihood and level of flooding downstream [54]. House recovery and construction in the Kegalle relocation project have been geared toward the construction of hazard-resilient houses. However, to reduce vulnerability caused by exposure to landslides, the Kegalle Relocation Project has overlooked other dimensions of exposure caused by a loss of employment, loss of access to land, and an increase in expenditure. Thus, exposure should be considered a multifaceted phenomenon in the future design and execution of planned relocation projects [55].

3.3. Vulnerability

Vulnerability to water-related disasters has been identified as a socioeconomic issue. Landslides are more common in areas that suffer from the loss of vegetation and increased human-mediated erosion resulting from the cultivation of fields [56]. Thus, the issue becomes interlinked with household income because many poor rural communities rely on cash crop products and their land in a high-risk area as their main source of income; therefore, many cannot afford to assume the risks of land degradation [45, 57]. As the agricultural sector in Sri Lanka is one of the most vulnerable to climate change, a thorough understanding of climate transition is critical for formulating effective adaptation strategies [58]. The economic impact of climate-induced disasters on Sri Lanka's agricultural, industrial, and service sectors and their subsectors. Thus, it seeks to explain a central paradox—there are winners and losers in terms of the effect of the disasters on sectoral growth. This poses problems for many developing countries seeking to aggressively raise economic growth targets. These targets typically do not adequately consider the impact of climate change on growth, nor do climate change likely have a different effect on different economic sectors [59]. Micro, small, and medium enterprises are also vulnerable to flooding on four fronts: capital, labor, logistics, and markets. Revenues suddenly fall below expenditures, and finding a workforce is another serious issue, as workers are the immediate victims of the flood. Entrepreneurs must find alternative or emergency logistic support to operate their businesses as floods severely damage the public infrastructure system [60]. To achieve the envisaged growth in such informal but essential sectors, rigorous efforts are necessary to mainstream climate change adaptation into national development policies and ensure that they are implemented at national, regional, and local levels.

In the gender context, women are more vulnerable to the flood disaster than men because of differences in employment status, income,

gendered social roles, social norms, and restrictions governing behavior. Hence, women's empowerment in disaster decision-making has been proposed by researchers and many international frameworks as a strategy to address vulnerabilities. Women's empowerment in disaster risk governance is expected to reduce their vulnerabilities and strengthen overall societal resilience to future hazards [61]. Although the communities experienced a significant reduction in flood damage after the project implementation, the impact on the community could have been much greater if the project considered the gender aspects concerning floods [62]. Thus, this study reinforces the argument that gender planning is vital for any development activity.

Poverty is also linked to flooding and subsequent displacement because the economic hubs of Colombo and Gampaha, which command high prices and suffer from a lack of land, continue to attract migration. Forty percent of the country's poor inhabit informal settlements in the outskirts of the urban areas of the capital region, driven by the search for opportunities and services [63]. As mentioned earlier, many of these settlements are built upon floodplains—the poorest demographics are most vulnerable to flooding events and habitually end up being displaced [63]. Poor and marginalized families living in unauthorised underserved settlements in flood-prone areas around Colombo were relocated as a flood risk reduction strategy to rebuild their lives in secure locations. The Sri Lankan experience suggests that relocation projects have been guided by project-specific guidelines, as opposed to common guidelines that have produced both successes and failures. These outcomes emphasize the need for specific guidelines for the three main stages of the relocation process: before displacement (pre-relocation), immediately after relocation, and two years after relocation in Colombo [64]. Conversely, in rural regions, low-income households depend on natural resources as their sole livelihood and are most vulnerable to financial losses resulting from floods and droughts because of lost agricultural products [65]. Furthermore, flood characteristics and household income level have a direct impact on economic loss in severe floods for both economic groups, with more significant impacts among poor households. Even for minor floods, inundation depth is the most significant factor affecting relative loss, irrespective of the economic group [66]. Concerns about the impacts of climate and hazards on agriculture are significant as 25.3% of the employed are engaged in agriculture [67]. Inter-household analysis of adaptive capacity, which represents the ability of a region or community to cope with and thrive in the face of change, indicates that poor households with fewer resources are risky anywhere, irrespective of where they are located [68]. Remote communities and regions are often disadvantaged in the aftermath of disasters. This is largely the result of inaccessibility caused by poor road conditions and lack of infrastructure and transport facilities, sometimes resulting in unequal aid distribution in certain regions [4,5,52]. Wealthy households are more sheltered against remoteness, as they can meet the needs for response and recovery through self-financing and access to insurance [69].

Additionally, situations of social vulnerability to flooding between and within regions are diverse. According to the multifaceted composite social vulnerability index, the regional disparity between rural and urban areas is notable for Sri Lankan vulnerability assessment [70]. The difference between rural and urban areas affected by floods is significant. In Sri Lanka, traditional rural areas seem to have a denser adaptive capacity than urban areas in terms of socioeconomic networks and related social capital like kinship, local communities, and religious bonding [71]. While the contribution of cities to economic activities has been emphasized, rural areas have been marginalized. The expansion of urban population has, in general, led to a decline in the rural population, which in turn has led to stagnation of government services, occurrence of natural disasters, increases in abandoned land because of fewer agricultural producers, and disruption of ecological balance [72]. The unsustainable situation faced by rural communities then compounds urbanization. Nevertheless, almost all sampled GNDs in previous studies [70] are quite vulnerable to flooding because their adap-

tive capacities consist primarily of resources, structural concepts, and agency.

4. Discussion

4.1. Socially emerging or embedded resilience in Sri Lanka

The practice of an administrative-oriented disaster management framework is a key element in creating a welfare-oriented community that is still recovering [73]. Sri Lanka is still struggling to recover from the disaster that struck the country 15 years ago. This reveals the need to strengthen the action plan for disaster management by identifying the barriers and challenges that exist in policies and frameworks, technology use in evacuation planning, implementation of evacuation plans, and capacity building of the community [73]. The earnest and urgent need to include local community perceptions in the initiative is to encourage the communities' perception of "being resilient to disaster" [74]. Community disaster resilience offers considerable promise as a guiding paradigm for promoting DRR and enabling disaster recovery through attention to and investment in local capacities for adaptation to a changing and uncertain environment [75]. It is said that community stakeholders use social networks within their neighborhoods as a primary survival strategy for "living with floods." In Sri Lanka, however, district-level committees find it difficult to facilitate long-term approaches, allocating responsibility for knowledge transfer and risk reduction. Additionally, different coping strategies were identified and used by flood victims in the reactive and recovery phases, during which appropriate and effective state interventions were absent. This resulted in victims becoming dependent because of the loss of material possessions and absence of empowerment and resilience were also not present as coping strategies, which should have been considered through the social work prism within the affected communities [76]. Ahangama et al. concluded that government efforts to achieve long-term flood resilience goals are more successful if multi-stakeholder networks can bridge this perceptual gap [77]. Furthermore, it is crucial to capitalize on the immediate post-disaster response period to integrate risk reduction and resilience-building activities in the early stages of the recovery timeline. Preparedness and resilience enhancement activities must align with the Sri Lanka CRF as it can help optimally utilize time and resources to enhance resilience in resource-limited contexts [78]. Moreover, social integration and resilience can emerge as latent functions of a disaster and play an important role in the recovery process of victims. Samarakoon and Abeykoon showed that receiving helping hands or, in other words, experiencing collective behavior continuously for over three months from non-victims lessens the psycho-social tension that might have arisen in the affected people. Additionally, the study showed that cultural values played a significant role in non-victims' decisions and attitudes toward affected people [79].

The cultural and social diversity of the community provide resilience of livelihood. The central mountainous area of rural Kandy provides a good example a community in Sri Lanka with "cultural resilience" as this community relies on longstanding cultural traditions for its survival. Daskon mentions how culture and traditional values strengthen livelihood resilience and argues that while the impulse for change may come from external influences, adaptation comes from within, through dynamics specific to the values of the people [71]. To mitigate flood risks, local communities have devised successful flood risk mitigation strategies, especially with the construction of dwellings. The adaptive capacity of vernacular dwellings is high, based on several flood risk mitigation strategies. Dilhani and Jayaweera have identified that even in the absence of modern materials and professional knowledge, vernacular dwellings satisfactorily comply with modern guidelines [80]. Landslide disaster-prone areas in Sri Lanka have local knowledge-based practices and value systems that enhance the disaster resilience of this small community. These include warning systems based on temple bells, settlement layouts, landscape, cooperative work (*Attam Kramaya*), and

stone retaining walls [81]. Sinhala folklore even considers the floods an aspect of cultural resilience; the frequent flooding they experienced every year during mid-May to September has been termed by them as the “floods which occur 45 days after Sinhala New Year,” which could be identified as the southwest monsoon rainy season [82]. In the Sri Lankan ecosystem, resilience can be increased by reducing exposure of cultivated plants to environmental stresses by planting a combination of trees and crops as agroforests. Agroforestry systems in Sri Lanka with a multi-layer canopy, which covers the ground, improve soil structure by incorporating tree biomass into the soil and reducing soil erosion to create a multi-layer defense mechanism against rain and wind erosion and increase infiltration capacity. Traditional agroforestry systems in Sri Lanka have been widely practiced throughout history as a means of slowing soil and other environmental degradation [83].

Further research is needed on concepts of resilience in the Sri Lankan disaster context, in order to conceptualize multi-institutional disaster resilience frameworks and develop a holistic framework for building national disaster resilience. Another area that needs further research is the concept of bouncing forward. Most recent studies are limited to evaluating the empirical grounds of the resilience concept “bouncing back.” However, further research should be conducted to understand how to use a disaster situation as an opportunity to change and improve further [40] so that resilience is contextualized in modern Sri Lankan society while climate change and disasters are occurring. Further, the literature review showed that resilience is complementarily emerging and embedded in society, in, for example, traditional knowledge and local historical ways, and from scientific research-oriented views. The field of environmental history as a field has thus helped to flesh out and radically revise our understanding of floods and landslides, which were previously being seen as ahistorical calamitous events; now, they provide a context for revealing complex relationships among geomorphological processes, biological pulses, and livelihood strategies. Consequently, the floods and landslides in South Asia are now acknowledged as ecological forces that is mediated by social, cultural, and political interventions rather than exclusively effects of nature [84]. Resilience is modeled alongside ecological systems as an object of social-ecological systems research. However, as a context for scientific interventions in environmental and disaster risk reduction policies, it appears to be an obstacle to achieving resilience-related policies. Based on a careful examination of Earth system science and associated discourses, we show that this instability of the society, combined with the ambition to integrate resilience in an encompassing system, poses serious problems for interdisciplinary resilience-related research and for more imaginative and inclusive collaborative efforts to tackle the climate change and disaster crisis, including, but going considerably beyond, policy and governance [12,13].

4.2. Overarching goal for creating a resilient society in Sri Lanka

Significant findings reveal that social capital evolved at different flood inundation phases (e.g., before, during, and after) and played a pivotal role in reviving village livelihoods affected by past water-related disaster events. Furthermore, bonding, bridging, and linking social capital strongly helped to reduce the adverse effects of past floods. Reciprocal support and resource mobilization have significantly helped secure and revive flood-affected livelihoods. Examples include providing information, food, water, shelter, and other basic needs, helping with evacuation, including the recovery, transport, and return of belongings, cleaning up contaminated households and public places, and providing emotional and financial support [85]. Moreover, most disaster-affected communities were not satisfied with resettlements owing to various cultural issues concerning cultural factors such as ethnicity, religion, social environment, natural environment, livelihood, and lifestyle [86]. The need was claimed to formulate people-centric relocation policy guidelines based on household surveys in select relocation settlements and key informant interviews with government officials and community leaders.

Subsequently, implementing such policies should be considered as a relocation process with an emphasis on securing their livelihoods, which will assist them in evading poverty [64]. Therefore, to support whole families, individuals, and community resilience, proper consideration of those cultural factors by resolving the identified cultural issues may direct the resettlement of Sri Lankan post-disaster reconstruction projects to achieve successful outcomes from a community cultural perspective [87]. The local people had an immediate need to strengthen their resilience in DRR because they live in vulnerable areas and have experienced disasters triggered by natural and human-induced hazards in the past and at present in some areas. As stated earlier, it is important to understand the basic information of the local context, including the hazard profile and the social, economic, and political aspects [88]. Further, in the Sri Lankan context, sustainable building codes exist but are not always legally enforceable. Incorporating the potential risks from natural hazards and their consequences to the building codes will minimize potential damage to human lives, property, business continuity, and the cost of emergency response by improving the resilience of the built environment [89]. Additionally, place-specific attributes that shaped community adaptations include cultural identity, co-management of community-based society, flexibility in choosing adaptive options, and indigenous and local knowledge systems and learning. It was also pivotal to make people aware of the severity of the impacts of climate change on their livelihoods and introduce climate-smart technologies to manage the consequences of extreme weather events [90]. These adaptive strategies and place-specific attributes provide new insights for scientists, policymakers, and communities in the region, enabling them to work together more effectively to support community adaptation [91]. Hence, resilience-building decisions based on such assessment methods can also be inconsistent. Abeyanake et al. suggested that decision-makers should revisit the practice of employing non-localized extra-local assessment methods without profoundly addressing the context-specific resilience-building needs [92].

Moreover, the indigenous agricultural and agroforestry system sustainability is vulnerable to rapid changes due to modernization, market changes, education levels, and inconsistent management decisions. To sustain the rural and agricultural society in Sri Lanka, policymakers must rethink the value of preserving indigenous agricultural systems and the negative outcomes of current management interventions that neglect the indigenous system. Therefore, careful interventions and innovations are needed to adapt the tank-based indigenous agricultural system of the dry zone of Sri Lanka to preserve ecological and socio-economic sustainability [93]. Mega infrastructure development, such as irrigation projects, is also an integral part of restoring paddy ecosystems affected by landslides and flood protection schemes for the upper and downstream [56,94]. It is important to allocate adequate resources to promote research on all aspects of climate change and their impacts by developing infrastructure, a critical mass of experts, and an institutional framework. The purpose is to link all stakeholders effectively to channel the formulated adaptation measures to the farming communities at the grassroots level [95]. However, it is unrealistic to expect development projects to be completely free of consequences on the environment and human lives. In addition, one must completely ignore the nature of politics in our society to believe that development projects should be initiated and implemented free of politics and the practice of clientelism. Therefore, strategies for mitigating potential disasters in such projects should also be examined concerning the politics within which such projects are implemented. These projects helped to study the problems and address the policy issues while mainstreaming climate information applications to reduce the vulnerabilities associated with paddy farming. This was achieved by rallying all stakeholders (academia, local level government institutions, farmer organizations, and media) under the leadership of the district secretary to form a local management and monitoring committee that helped identify the most effective policy framework [96]. Furthermore, different risk assessment and management strategies will support more suitable management measures (e.g.,

Table 2
Overview of resilience in Sri Lankan contexts.

Scope	Keywords to bridge the gap	Previous Research
Individuals, Family	impact on household income, social impact, social factor which influence the decision to live in a high-risk area, social networks within the neighborhoods, social integration, collective behavior, reciprocal support and resource mobilization	E. N. C. Perera, D. T. Jayawardana, P. Jayasinghe, R. M. S. Bandara, and N. Alahakoon [44], C. K. M. Deheragoda [45], J. Askman, O. Nilsson, and P. Becker [48], H. U. S. Samaraweera [71], H. M. M. S. D. Herath, A. M. A. Saja, R. Piyadasa, and Z. Zarouk [73], K.A.C. Dilhani and N. Jayaweera [76], A. Y. Karunarathne [80]
Communities	Regional disparity, human settlements, adaptation strategies, capacity building, making the communities' perception, loss of material possession, bridging the perceptual gap, knowledge-based practices, community adaptations	P. Jayasingha [52], M. Esham and C. Garforth [55], A. Y. Karunarathne and G. Lee [67], D. K. Rathnayake et al. [68], E. S. Ranjan and C. C. Abenayake [69], B. Mayer [70], N. Ahangama, R. Prasanna, and D. Blake [72], U. A. Dasanayaka and Y. Matsuda [77], Y. Kaluarachchi [81], N. W. M. G. S. Navaratne, W. A. D. P. Wanigasundera, and P. C. B. Alahakoon [85]
Public Policy, Society	inaccessibility, unequal distribution of aid, lack of infrastructure and transport facilities, gender, poverty, relocation, flood protection support, legal land ownership, disaster insurance, the use of technology in planning, implementation of evacuation plan, preparedness and resilience enhancement activities, building codes and cost of emergency response, management measures and stakeholders' participation	Ministry of National Polices and Economic Affairs and Ministry of Disaster Management [4], Ministry of Disaster Management and Ministry of National Policy and Economic Affairs [5], R. R. Churchill and D. M. Hutchinson [16], V. Hewawasam and K. Matsui [50], K. Wickramasinghe [51], P. Jayasingha [52], K. Hemachandra, D. Amaratunga, and R. Haigh [58], M. Friedrich [60], N. Fernando [61], D. K. Rathnayake et al. [68], H. M. M. S. D. Herath, A. M. A. Saja, R. Piyadasa, and Z. Zarouk [73], S. Nissanka, D. Amaratunga, and R. Haigh [84], K. Edirisooriya [92]
Ecological Systems	climate change, development activities in river catchments, influence of anthropogenic activities, change in land use pattern, agroforestry systems, tank-based indigenous agricultural system, paddy ecosystems	P. Dissanayake, S. Hettiarachchi, and C. Siriwardana [49], L. Manawadu and V. P. I. S. Wijeratne [46], P. Jayasingha [52], T. Hewawasam [53], M. De Zoysa and M. Inoue [79], N. Abeywardana, B. Schütt, T. Wagalawatta, and W. Bebermeier [88], M. Senanayake [89]

the trade-off between cost and effectiveness) and stakeholders' participation (e.g., public participation through workshops) [97].

To summarize this discussion using the framework proposed by Shimizu and Clark [1], Table 2 is presented in the matrix. Research on resilience under climate change in Sri Lanka published between 2010 and 2021 indicates variation in research themes and scope maturity, such as family and individuals, communities, public policy and institutions, and ecological systems. According to Shimizu and Clark, from a systems perspective, individuals are not the granular core of societies but form systems and structures for resilience through different organizations or communities [1]. Although this underlying relationship is basic, understanding is a critical entry point for the system views of resilient societies. Thus, it is essential to support the resilience of the whole and each layer and leverage the diversity and sustainability of livelihoods in the Sri Lankan context. As such, addressing boundaries among systems or structures at different scales is pivotal for resilient societies and can be enabled through public policy and their actual lives. Building on this premise, prior sections focus on how each level/scale relates to building or rebuilding the discourse of resilience by highlighting advanced cases and practices that specifically address resilience in the context of a modern risk society and uncertainty under climate change.

5. Conclusion

This review analyzes how the discourse of “resilience” is contextualized in modern Sri Lankan society while climate change and disasters occur. As a concluding remark, the literature review showed that resilience is complementarily embedded in an emerging culture and society, such as traditional knowledge and local historical ways, from a scientific research-oriented view and wide international policy view in Sri Lanka, which has been marginalized in the international climate change policy arena. Elements such as traditional knowledge and local history and culture, which seem unrelated to coping with crises and changes, are often focused on resilience, disaster prevention, and risk reduction. Moreover, the review indicated that resilience could be considered the accumulation of stable states and supporting mechanisms found in the interaction between the normal phase and emergencies in elements unique to the region. Thus, the ecological and community concept of resilience has been translated into a more social orientation toward the emergence of such climate change in the Sri Lankan context.

This study suggests several future research directions that integrate resilience into societies and practices. It is critical to support the re-

silience of the whole and each layer and leverage the point of diversity and sustainability of livelihoods in the Sri Lankan context. Disaster risk assessment and resilience analysis are critical parts of the co-knowledge production process in terms of inputs to individual risks for policy evaluation under drastic climate change situations. Often, we overlooked the importance of defining linkages among different risk and resilience assessments, analyses, and policy evaluations. Specifically, the key points associated with resilience were specified in the resilience view. Hence, there is a need for more in-depth research that firmly embeds the concept of resilience in the disaster and climate change literature. This study does not fully consider more theoretical and empirical gaps in resilience and resilience against new threats, such as the COVID-19 pandemic and the uncertainty it has created. Therefore, further research should be conducted to determine the challenges facing resilient societies in Sri Lanka.

Declaration of Competing Interest

The authors declare no conflict of interest.

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Supplementary materials

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