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COMMUNITY RESILIENCE TO MASS FLOODING EVENT OF 2017: A CASE OF SEVERELY INUNDATED LOCAL ADMIN AREAS IN KURUWITA DSD, SRI LANKA

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ABSTRACT

Sri Lanka is an island country situated in the tropics that has adversely been affected by many hydro-meteorological disasters such as floods, landslides, torrential rainstorms, and droughts for years. By contrast, the country experienced mass flooding events in 2003, 2016, and 2017 during the past two decades. Especially, examining of the level of community resilience of disaster affected areas plays a cardinal role in revivifying victims' livelihoods. On this context, this paper sheds some lights on the investigation of community resilience in eight flood affected Grama Niladari Divisions (GNDs) situated in Kuruwita DSD in Sri Lanka. This study occupied with the mixed-research method approach covering both the qualitative and the quantitative aspects of resiliency indicators. Mainly the study collected the empirical data covering the resiliency indicators/variables such as households' educational level, monthly income, social network degree densities, number of organizational memberships, and the count of mostly supported friends. The data collection course covered 114 flood affected households situated in eight GNDs, in accordance with the random sampling method. The study used general data normalization mechanism in order to normalize all the resilience indicators. In addition to that the study also occupied with Getis-Ord Gi* spatial statistic test in order to determine the hot spot and cold spot of community resilience for flooding. The results revealed that the GNDs such as Miyanadeniya, Ovitigama, Pahalagama, Kithulpe exemplified a higher proportion are at risk of low resiliency for mass flooding event occurred in the year 2017. The rest of GNDs showed a lower level of risk on the community resilience. This paper bridges some gaps of the extant body of literature by examining the disaster resiliency discourse in disaster risk management in the context of Sri Lanka.

KEYWORDS: Community resilience; flood disaster management; social networks; Sri Lanka; disaster risk reduction

1. INTRODUCTION

Hydrometeorological disasters have been become one of the serious natural calamities in both Northern and Southern hemispheres in the world. Global climate change scenarios can be identified as the key reason for accelerating hydrometeorological disasters throughout the world (Harvey, and agencies, 2022; IPCC, 2022). Deforestation and the emissions of harmful gases to the atmosphere by a range of anthropogenic activities are the salient causative factors that help to accelerate global warming (Harvey, 2022; IPCC, 2022). On the one hand, global warming has been augmenting the drying out of agricultural lands and forest fires (see, Gkousarov, 2022). On the other hand, there has been a strong association between torrential raining events, cyclones and global warming scenarios (Carrington, 2022a). In this context, flood disasters are being becoming one of the serious natural calamities among the hydrometeorological disasters, in the world (Carrington, 2022b; Guardian staff and agencies, 2021). Very recent mass flooding events such as German and the Europe floods implying that the occurrences of climate change related natural calamities will be adversely accelerated by many folds in the future. This is because the people who are living in low lying and down valley areas will be more vulnerable for mass flood inundation.

This is because understanding of the current threats of environmental and natural calamities will be more important. Particularly, in the case of poor and developing countries, their consequences will be much worse. This is because investigating the risky areas of developing countries for natural hazards will be a fundamental requirement. Similarly, Sri Lanka as a middle-income developing country, has been experienced mass flooding events for decades (Karunarathne and Lee, 2019; Jayawardana et al., 2019; Karunarathne and Andriesse, 2018; Karunarathne and Lee, 2020a; Churchill and Hutchinson, 1984; Karunarathne, 2021). Especially, areas where situated in the Wet-Zone catchment of Sri Lanka have adversely been receiving torrential rains during the South West Monsoon period, will also be more vulnerable for flooding (Karunarathne and Gress, 2022; Karunarathne and Gress, 2022). Therefore, understanding people's disaster resilience status will be more worthwhile for flood disaster mitigation and preparedness practices. In this context, the aim of this paper is to shed some lights on investigating the Disaster Resilience of flood-affected households in rural areas, in Sri Lanka.

Particularly, disaster resilience has been become one of the important metaphors in the disaster risk reduction (DRR) applications, throughout the world. According to the existing body of literature, the disaster resilience is multi-dimensional and multi-facets in nature. Basically, the notion of community resilience has interlaced with the communities' wellbeing and illbeing. It is representing the each and every aspect of the human lives. With the cumulative impacts of Covid 19 pandemic and so called hydrometeorological disaster events, many areas throughout the world have been experienced adverse impacts of cascading disasters. This is because, the need of understanding of resilience to natural calamities has been come to the fore (Karunarathne and Lee, 2022; Adger et al., 2005). In this context, there are some research applications can be found on analyzing the resiliency of disaster impacted communities (Cutter et al., 2014; Arrighi, Carraresi, and Castelli, 2022; Heinzlef et al., 2021).

In Sri Lankan context, there are only very little number of research applications can be found on the notions of community and disaster resilience. Therefore, this study will bridge the significant gap in the extant body of literature. In this context, this study seeks to address the following research questions; What are the geographies of disaster resilience of flood-affected households in Kuruwita surveyed eight GNDs? How to identify the cool and hot spots of disaster resilience? The rest of the paper has structured as follows; the section 2 discusses the conceptual and application contexts of community resilience to natural disasters. the 3rd section engages with the methodological considerations. The 4th section gives the empirical results and section 5 occupies with discussion and conclusion.

2. COMMUNITY RESILIENCE TO NATURAL DISASTERS

In accordance with W.N. Adger's idea, "social resilience is the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change" (Adger, 2000). In the extant body of literature, the term "community resilience" has been used in similar meaning to what W.N. Adger termed the "social resilience". For instance, according to Cutter, Ash, and Emrich (2014), "resilience, especially the concept of community resilience is becoming the de facto framework for enhancing community-level disaster preparedness, response, and recovery in the short term, and climate change adaptation in the longer term". Both the definitions exemplify the similar characteristics of improving the ability of community in terms of preparing for, responding to, and recovering from the bad consequences of natural calamities. However, yet, the defining of resilience is debatable and implies such multi-facet considerations, according to the extant body of literature.

Community resilience has been eroded by the impacts of natural disasters in many folds. In addition to that, there are a range of socio-economic and demographic aspects that need to be considered in understanding the resilience and vulnerability. abovementioned aspects can be explained as significant variables that show the status of resilience. More importantly, variables such as economic/income, education, health, demographic factors, gender and other related ecological factors are more important in order to determine the level of resiliency of such a community (Karunarathne and Lee, 2022; Karunarathne, 2021; Cutter et al., 2014; Borie et al., 2019). Abovementioned variables need to be considered for assessing the community resilience in broader way. In the case of more ad-

vanced and improved resilience circumstances, the disaster consequences will be minimal. This is because people's adaptive capacities. In other words, the coping capacity of people is very high, if their resiliency has improved. This association is very important in understanding the concept of community resilience.

This is because, the resilience plays a cardinal role in determining/understanding the existing and actual nature of vulnerability to disasters (Karunarathne and Lee, 2020a). In contrast, the erosion or buildup of resilience determines the severity of impacts of extreme events (see, Adger et al., 2005). On the other hand, if the community resilience is strong enough to cope with and recover from disasters, they minimally depend upon/reliance on the external supports/resources (Frazier, Thompson, and Dezzani, 2014). In this context, the community resilience encompasses the notion of disaster resilience in all the means. Therefore, disaster resilience makes the individuals, groups of people, and community stronger and empower, especially, those who are vulnerable to potential natural calamities and disasters. This is because improving the community resilience is one of the fundamental requirements in disaster risk reduction and management. One of the key fundamental requirements for community level disaster mitigation is improving the community resilience (Waters and Adger, 2017; Cutter, Ash, and Emrich, 2014).

More importantly, resilience can be built through social capital metaphors such as trust, reciprocity, reputation, and resource mobilization via socio-organizational networks (Adger, 2003; Karunarathne and Lee, 2019; Karunarathne, 2021; Karunarathne and Gress, 2021). This association is pivotal important in improving community resilience, of course since we are on quicksand due to climatic change. More importantly, the notion of community resilience can also be identified as the opposite of the conception of vulnerability. If some geographical settings exemplify very high vulnerability, the same areas' resiliency could be very low. This is because it is possible to understand such a complementary interlaced nature between two notions. This also an advantage of understanding the inherent characteristics of both the conceptions.

Therefore, improving the residency of such a community means that the reducing of their vulnerabilities. In other words, when improving the education, income, livelihoods strategies, and health security their adaptive capacity will goes up amid ameliorating vulnerabilities. On the other hand, social networks and social capital mobilization is one of crucial metaphors in improving community resilience (Karunarathne and Lee, 2022; Misra et al., 2017). Especially, a range of resource mobilizations have importantly been done via social support networks and social capital metaphors will be paramount important for a developing country like Sri Lanka (Karunarathne and Lee, 2019; Karunarathne and Lee, 2020a). Particularly, cultural capital and native ethos significantly impact on the hospitality and altruistic nature of helping others in the circumstances where natural calamities impact people (Karunarathne and Lee, 2019; Daskon and Binns, 2010). This is because a plethora of helping ties have been observed in the past Sri Lanka flood events, which have been helped to improve the resiliency of flood victims by many folds (Karunarathne, 2021; Karunarathne and Gress, 2022). In this context, understanding of disaster affected households' resiliencies and measuring the intertwined variables will be very worthwhile. Moreover, this work will bridge the existing gaps of the resilience research applications in the Sri Lankan discourse.

3. METHODOLOGY

3.1 Study area

The study area is Kuruwita DSD in Rathnapura district, Sri Lanka. There are eight Grama Niladari Divisions (GNDs), which are mostly affected by 2017 mass flooding event were considered for the empirical data collection. According to the household survey, the average inundation level ranges from 3.45 feet to 9.63 feet. This is because many households which are situated very close proximity to Kuru River (which is one of the main tributaries of Kalu river) and also in low lying areas were adversely impacted by the rushing floodwaters. In particular, the flooding event experienced in May 2022 also accounted for one dead and several damages to households. Therefore, the surveyed GNDs have been experienced flooding events for years. The situation has been serious by the ongoing climate change scenarios. In accordance with the author's experience, in the year 2021, even after the conclusion of

the South-West monsoon in September, the Wet Zone catchment of Sri Lanka experienced many torrential rains during the months of October, November and even until the middle of December 2021. More importantly, these scenarios imply that Sri Lanka as an Island country has also been experienced unexpected hydrometeorological calamities. This is because the country has a range of serious challenges by ongoing climate change phenomenons.

3.2 Data collection

The empirical data collection course was done based on the households that were affected by 2017 mass flooding event. Many of households have inundated due to the overflow of Kuru River. The sampling frame was developed based upon all the damaged households by 2017 mass flooding event and the 114 mostly affected households were selected for the household survey following the simple random sampling mechanism. The response rate was 100% by means of having the consent of each and every household. More importantly, all the respondents were requested to attend the questionnaire survey/interviews, only those who personally experienced the 2017 mass flooding event. And also, the majority of respondents were head of the households. They explained their credible experiences including how they managed everything in the flood inundation event. Socioeconomically many of people in the surveyed households/GNDs have solely been involved with the Kuru River for their livelihood activities including gem mining. The household questionnaire survey included both open ended and closed ended questions. At least one hour's time (average time) required to complete the questionnaire. In addition to that, five focus group interviews conducted representing some of a Many of the influential variables for measuring the resiliency of flood victims considered and explained in the methodology section. The data collection course conducted during more than ten months period in the year 2018.

3.3 Key method

This study occupied with the mix-research method approach including both the qualitative and quantitative data analyzing ways (Karunarathne and Lee, 2020b). Basically, the study considered the following variables in order to measure the resiliency levels of each and every household; Educational level of household members especially including the household head's education background; Monthly income of each household including other income sources if any; Network degree density of each household; number of memberships of village organizations; and Number of friends. Regarding the education level, the schooling grade number is used. For monthly total income, network degree density, number of village organizations' memberships, number of friends, actual values were considered. More importantly, the study occupied with the general normalization procedure (see, Karunarathne and Lee, 2020b; Rand et al., 2020) to scale up all the vales to one scale respectively, which have been representing different measuring units. For the mapping purposes, the average value of all the normalized variables was used. Following normalization formula was used for the data normalization process (Karunarathne and Lee, 2020b; Mainali and Pricope, 2017; Adu, et al., 2018).

$$\text{Normalization Index}_{s_{ov}} = ({}^{s}ov - {}^{s}min)/({}^{s}max - {}^{s}min)$$

Where, represents the observed value of variable that related to household s and and are maximum and minimum values of the considered variable respectively. According to S. Cutter and colleagues (Cutter et al., 2014), Min-max normalization considers 0 as the minimum values of the considered variable and 1 as the maximum values. This can be identified as one of the best ways to rearrange the raw data which is represented by different scales and measuring units. The study also occupied with Getis-Ord Gi* spatial statistic test (Ord, and Getis, 1995; Sanders et al., 2013), in order to determine the hot spot and cold spot of community resilience for flooding. Basically, hot spots imply to households with relatively improved or high resiliencies while cold spots indicate the households with low resiliency or in other words households with high vulnerability for flooding.

4. EMPIRICAL RESULTS AND DISCUSSION

The analysis of the results showed that the community resilience is varied among the variegated geographical settings. In other words, the flood affected households of surveyed GNDs in Kuruwita DSD exemplify that the

different resilience figures/levels among different GNDs. The table 1 shows the average resilience values with the Minimum and Maximum actual values of surveyed household (n = 114) which are situated in different GNDs (n=8). The GNDs such as Galukagama and Pahalagama exemplify the highest and the lowest resilience index values respectively.

All the resilience indicators range from zero to one. The zero represents the lowest resiliency amid the one indicates for the highest resiliency level. It is more important to understand the disaster resilience situation of each GND in accordance with the different resilient indicators. Educational level exemplified diverse spatial patterns. According to the revealed results, Kitulpe and Pahalagama GNDs show the highest level of education, varying from grade 9 to grade 11 respectively. Despite the GNDs such as Ihalagama, Galukagama, Miyanadeniya, and Ovitigama show the large difference of educational levels, such as "No Schooling" to "Degree". Of course, "No schooling" indicates the severe vulnerability for flood disasters amid the "Degree" level indicates the highest resilience for flooding events. This is because the resiliency of flood victims can be improved via higher educational achievements (see, Cutter, Ash, and Emrich, 2014).

Table 1: The average resilience values with the Minimum and Maximum actual values of surveyed household

GNDs/Surveyed Households (sample size)	Resilience Indicators				
	Educational level	**Monthly Income***	**Network degree density**	**# of memberships**	**# of friends mostly supported**
1. Kitulpe /10	0.666667 (no schooling/ grade 11)	0.619491 (18,000/60,000)	0.74 (1/2)	0.74 (1/2)	0.215 (42/60)
2. Ihalagama /16	0.541667 (no schooling/ degree)	0.677436 (14,000/49,000)	0.7125 (1/3)	0.7125 (1/3)	0.311285 (0/50)
3. Galukagama/26	0.625000 (no schooling/ degree)	0.715123 (9,000/45,000)	0.700 (0/5)	0.700 (0/5)	0.267329 (0/51)
4. Theppanawa/9	0.537037 (no schooling/ grade 12)	0.615819 (15,000/ 47,000)	0.8 (1/1)	0.8 (1/1)	0.300 (30/48)
5. Pahala Kuruwita / 11	0.621212 (no schooling/ grade 10)	0.674884 (15,000/36,000)	0.781818 (1/2)	0.781818 (1/2)	0.285606 (15/50)
6. Miyanadeniya /18	0.555556 (no schooling/ degree)	0.716102 (6,500/ 44,000)	0.7 (1/4)	0.7 (1/4)	0.317052 (38/60)
7. Pahalagama/8	0.666667 (no schooling/ grade 9)	0.629237 (20,000/35,000)	0.625 (1/4)	0.625 (1/4)	0.381597 (35/50)
8. Ovitigama /16	0.614583 (no schooling/ degree)	0.552436 (15,000/63,000)	0.700 (1/2)	0.700 (1/2)	0.4296875 (30/53)

*Note: Total sampled households= 114; All the values are normalized and averaged. Within bracket, (actual values: Min/Max of respective HH); * in Rupees*
Source: Calculated by the author based upon the surveyed empirical data, 2022.

Educating vulnerable people has been come to the fore, since climate change-induced calamities have rapidly and steeply been developing. Despite, 47 family members were found with "No schooling" category among the 114 surveyed households. Monthly income has also been widely considered as one of the crucial resilience indicators of constructs (see, Karunarathne and Lee, 2020b; Cutter, Ash, and Emrich, 2014; Misra et al., 2017). More importantly, the monthly household income has ranged from 6,500 LKR (in Sri Lankan Rupees) to 63,000 LKR which are represented Miyanadeniya and Ovitigama GNDs respectively, in accordance with the findings. The average monthly income of the flood-affected families indicated as 24,000 LKR and it is tremendous that the 75 households are below the average monthly income. The monthly income of 39 households are above the average monthly income. Abovementioned figures are indicated that the 66% of households are more likely to at risk due

to the severe income vulnerability or low income related resiliency for flood disasters. Moreover, according to Karunarathne and Andriesse (2018), 7.7% households of these areas are belonged to the poor households based upon the official poverty line in 2012. This is because the resiliency improvement mechanisms should come to the fore, in terms of revivifying the flood-affected livelihoods. According to the revealed results, the lowest overall monthly income shows in the Ovitigama GND (0.552436) amid the largest values are represented by Miyanadeniya (0.716102) and Galukagama (0.715123) GNDs (Table 1).

Network degree density has also been considered as one of the cardinal variables that indicating the resilience of disaster affected people (Karunarathne and Lee, 2020; Misra et al., 2017; Karunarathne, 2021). In accordance with the revealed results, Miyanadeniya GND exemplifies the lowest network degree (0.023000), compared to the highest figure (0.213333) represented by Theppanawa GND. Ihalagama (0.037000) and Galukagama (0.037333) GNDs also indicate quite lower network degree figures compared to the rest of GNDs. In other words, Miyanadeniya, Ihalagama and Galukagama GNDs have been exemplified lower resiliency for flood disasters and their flood vulnerabilities are very high. The reciprocal support networks and related social capital metaphors gigantically help to foster the resiliency of disaster victims (see, Karunarathne, 2021; Karunarathne and Lee, 2020a). Especially, their reciprocal support network legacies have been mattered to accelerate and succeed the resource mobilizations. This has also been interlaced with the trusting others as well (Misra et al., 2017; Karunarathne and Lee, 2020b). By contrast, the rural flood inundated areas of Sri Lanka has been experienced such strong social networks' supports, indicating the prowess of traditional social capital metaphors (see, Karunarathne and Lee, 2019). These areas always have exemplified good network and organizational supports that other areas can't experience. Nevertheless, the severity and the complexity of other indicators are also important when determining the level of resiliency. The rationing of care provided by the government and non-governmental organizations are also helped to foster the resiliency of flood victims of these areas (see, Karunarathne and Gress, 2022).

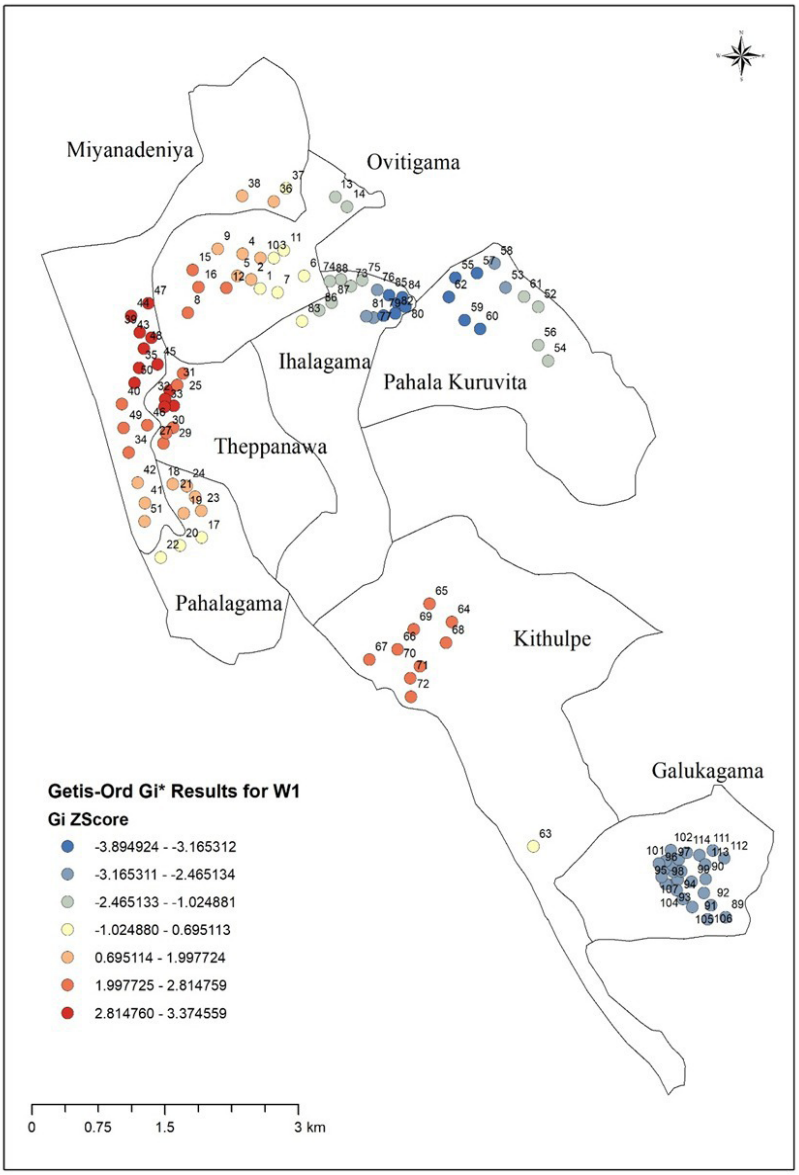
Number of memberships of organizations and the number of mostly supported friends also considered as influential metaphors that helped to improve the resiliency of flood victims. More importantly, these variables indicate the behaviors of bonding, bridging and linking social capital forms (see, Karunarathne and Lee, 2019). The results demonstrate that Galukagama GND exemplified both the lowest (n=0) and the highest (n=5) organization memberships. The organizational memberships generally help to foster the social network fabrics among villagers enormously (Htein, Lim, and Zaw, 2018; Karunarathne and Gress, 2022). Generally, the majority of surveyed households indicted that they have one or more of memberships. According to the table 1, Kithulpe and Miyanadeniya GNDs showed the highest figures of the number of supported friendships (n=60) amid the lowest records indicated in GNDs such as Ihalagama and Galukagama. The collaborative friends, family members, relatives, and neighbors are very crucial in terms of search and rescue operations, in particular, before and during flooding phases. By contrast, when consider the ongoing inevitable climate change scenarios, above discussed resiliency indicators are very influential for measuring and assessing the coping and adaptive capacities of vulnerable people for disasters.

Figure 1 demonstrates that the hot spot analysis results of flood disaster resilience. The reddish colored symbols indicate that the most vulnerable households for inundation and the same households exemplify the lowest resiliency levels. Households which are situated in Theppanawa and Miyanadeniya GNDs imply that they are mostly vulnerable for flood inundation compared to the rest of GNDs. Flood affected households located in Ihalagama, PahalaKuruwita, and Galukagama GNDs revealed as cool spots. In other words, their resiliency levels are high compared to the rest of survey households. The results imply that the same households' vulnerabilities are very low compared to the other households.

More importantly the legacies of social support network play a cardinal role in revivifying the flood affected livelihoods in Sri Lanka (Karunarathne and Lee, 2020a; Karunarathne and Lee, 2022). This study also explored the prowess of social capital and related social support reciprocal networks in the context of disaster resilience. Of

course, the network degree density exemplifies the community collaboration and resource mobilizations vis social support networks. In other words, there are only very few studies are in the existing body of literature by examining the resiliency of disaster victims considering their actual social network metaphors. Basically, their intertwined and altruistic nature work as a de facto mechanism to heal many worries of flood victims as this work profoundly exemplified.

Figure 1: Hot Spot analysis results of resiliency in surveyed households



Source: Author's cartographic design, 2022.

Figure 1 also shows the spatial patterns of resiliency distribution among the variegated geographical settings. Ovitigama GND also has two households that categorized under the high resiliency or low vulnerable households. Their adaptive capacities have been shaped by the high socio-economic and social capital characteristics. Since the colossal impacts have been experienced in many GNDs by 2017 mass flooding event, there were credible evidence on the consequences/destructions of households in large numbers. This is because identifying the resilience levels of impacted households is very important since the results will have profound effects on the resiliency improvement strategies. This work explored the difference and geographies of resiliency levels of eight GNDs situated in Kuruwita DSD, Rathnapura district, Sri Lanka. Surveyed households still being affected by flood inundations mainly due to the annual/seasonal overflow of Kuru Ganga which is one of the main tributaries of Karu Ganga. Therefore, the results revealed by this work will help to mitigate the impacts of future mass flooding events. More-

over, a very little number of efforts have been made on the examining of the resilience discourse of Sri Lanka. This is because this work also fills the gaps of the extant body of literature of community resilience in the context of disaster risk reduction and management.

5. CONCLUSION

The study exemplifies the community resilience situations to mass flooding event occurred in 2017 and how the community resilience varies among the variegated geographical settings called GNDs (n=8). The study considered and surveyed 114 flood affected households which are situated among the flood affected 8 GNDs. The results revealed that the community resilience has varied among different affected households and also among different GNDs. According to the results revealed, the community resilience of flood affected households have shaped by the community support networks and their resource mobilization legacies. In other words, the reciprocal support networks and their resource mobilizations have influenced to improve the community resilience of flood victims. It is also observed that a distinct spatial patterns of resilience among flood victims. This is because a record number of highly and slightly inundated households were observed. On the other hand, the status of households, members' socio-economic and demographic characteristics have shaped the level of resiliency of each and every household. Hence, the results revealed that households have experienced abrupt and cumulative impacts by the rushing floodwaters. At present there are multiple threats such as Covid 19 pandemic, flooding events, coups and melt-downing the economy, and also the climate change impasses which have been chasing the vulnerable people of Sri Lanka. In addition to the abovementioned reasons, the Ukraine invasion also has been intensified a range of foreign trade impasses for months. Tourists have been arriving from both the countries have stopped and all the imports and exports activities with two countries have already been challenged and stopped. This is because the current situation of Sri Lanka has adversely been submerging. The policy implications of this work mainly focused on the improving of resiliency of rural flood affected livelihoods. In other words, there wounds must be healed by mainly focusing on livelihood strategies of flood victims.

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