Simple Flood Risk Assessment Method to GND Level in Sri Lanka

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1. Introduction

Natural and man-made disasters are increasing worldwide and floods remain at the top (UNISDR, 2017; CRED, 2020). Concerning Sri Lanka, floods are the most frequent and threatening disaster at present while landslides, droughts, high winds, tsunamis, human-elephant conflict, etc. occur in different scales (MDM, 2014; Eckstein, et al., 2019). Theoretical concepts of disaster management affirms that disasters should be managed in the phases of the Disaster Management Cycle which include prevention, mitigation, preparedness, response, rehabilitation, and reconstruction (Carter, 2008). Pre-disaster management phase is given more significance at present and the disaster management activities are planned on the results of disaster risk assessments (Wanninayake, et al. 2023; Wanninayake, et al. 2024). In the literature, though there are many disaster risk assessment (DRA) methods, there is a gap of simply applicable method to the local level in Sri Lanka which can be applied with available data (DMC, 2019; Wanninayake, et al. 2023). Accordingly, this study aims to propose a simple flood risk assessment method to the local level in Sri Lanka. However, DRA methods should be developed for multiple disasters in the future concerning the relevant factors.

2. Materials and Methods

The study area is the lower part of the Deduru Oya basin in Sri Lanka. The most flood-vulnerable four Divisional Secretary Divisions ((DSD); Chilaw, Arachchikattuwa, Pallama, and Bingiriya were selected for the study. About 425 families from the most flood-vulnerable 15 Grama Niladhari Divisions (GND) were selected for the study as the sample following the stratified random sampling method. Accordingly, primary data were collected from this sample using several methods such as questionnaire survey, key person interviews, and field observations. Several sources such as journal papers, PhD thesis, manuals, data records from Divisional Secretariates (DS), District Disaster Management Coordinating Units (DDMCU), etc. were used to collect secondary data. The qualitative data analysis method was used in this study.

3. Results and Discussions

The flood risk assessment model developed for the GND level is simple to apply. However, the model was developed on theoretical base. Accordingly, the following equation was used to develop the model (Equation 1). Several researchers have used this equation to assess disaster risk with some alterations relevant to their studies (Davidson and Shah, 1997; Bollin, et al, 2003; Wanninayake, et al, 2023). By the components of hazard, exposure, and vulnerability a minimum number of variables were used in the current study aiming to develop a simple model.

$$Risk = Hazard + Exposure + Vulnerability \quad [1]$$

The current model proposes to assess the flood risk by GNDs, accordingly, the unit of study is the GND. Most of the data needed for the proposed assessment are available in the relevant DDMCUs and DSs. In occasions where the secondary data are not available in the above sources, those data can be collected from the community without hindering the effort.

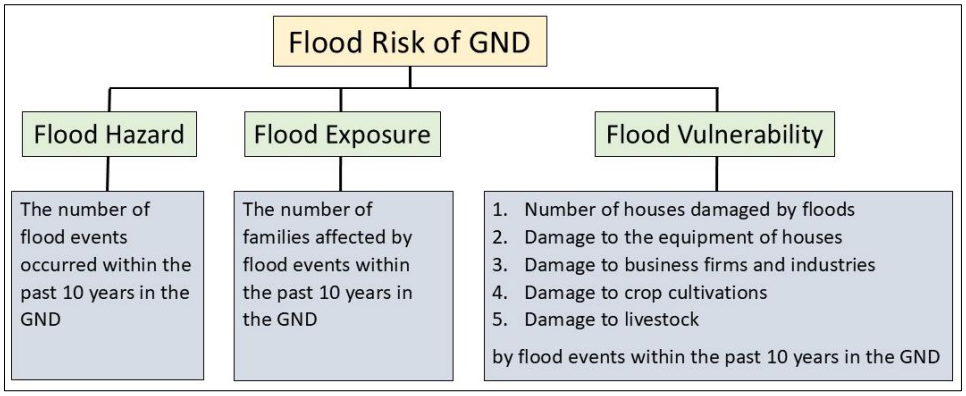

Figure 2: Proposed flood risk assessment model (Source: Developed by the researcher)

Accordingly, the following model (Figure 1) can be used in assessing the flood risk in GNDs.

Variables that should be considered under the factors of hazard, exposure, and vulnerability are mentioned in the model. In assessing the flood risk by the above variables, the levels of significance are specified and weighted on the opinions of the respondents and the secondary data.

Accordingly, the flood hazard of a GND should be calculated based on the number of flood incidents in the GND within the previous ten years. Hence, the GNDs can be categorized and assigned weights as in Table 1.

Table 1 Weights for Flood Hazard

Number of flood incidents	Weightage
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10 or above	10

Flood exposure of a GND should be calculated based on the number of floods-affected families in the GND within the previous ten years. Here, the percentage of the total families of the GND should be considered. Accordingly, GNDs can be categorized and assigned weights as in Table 2.

Table 2 Weights for Flood Exposure

Number of flood-affected families (%)	Weightage
0	0
1 – 10	1
11 – 20	2
21 – 30	3
31 – 40	4
41 – 50	5
51 – 60	6
61 – 70	7
71 – 80	8
81 – 90	9
91 - 100	10

Flood vulnerability of a GND should be calculated based on five variables;

- Number of houses damaged by floods
- Damage to the equipment of houses (Eg: clothes, furniture, utensils, etc.)
- Damage to business firms and industries
- Damage to crop cultivation (EG: paddy, vegetables, and other seasonal crops)
- Damage to livestock (Eg: cattle, pigs, chicken, etc.)

Accordingly, vulnerability can be calculated based on the number of incidents reported in a GND within the previous ten years. Here, the percentages of the total families should be considered. Through the summation of weightages for the five variables, total value for vulnerability should be calculated for the relevant GND. In damage calculations monetary values are not considered to maintain the simplicity and the applicability of the model. Accordingly, GNDs can be categorized and assigned weights as in Table 3.

Finally, as stated in the equation, flood risk can be calculated in summation of all values for a GND. In this model, there are some limitations i.e. usage of few variables, sometimes floods may affect a part of a GND but the whole GND is considered. However, this model is easier to apply by the local level stakeholders. Most of the time this assessment can be done by the Development Officers of DSs with the help of Grama Niladharies, and the community with the available data.

Table 3: Weights for Flood Vulnerability

Number of houses damaged by floods (%)	Weightage	Damage to the equipment of houses (%)	Weightage	Damage to business firms and industries (%)	Weightage	Damage to crop cultivations (%)	Weightage	Damage to livestock (%)	Weightage
0	0	0	0	0	0	0	0	0	0
1 – 10	1	1 – 10	1	1 – 10	1	1 – 10	1	1 – 10	1
11 – 20	2	11 – 20	2	11 – 20	2	11 – 20	2	11 – 20	2
21 – 30	3	21 – 30	3	21 – 30	3	21 – 30	3	21 – 30	3
31 – 40	4	31 – 40	4	31 – 40	4	31 – 40	4	31 – 40	4
41 – 50	5	41 – 50	5	41 – 50	5	41 – 50	5	41 – 50	5
51 – 60	6	51 – 60	6	51 – 60	6	51 – 60	6	51 – 60	6
61 – 70	7	61 – 70	7	61 – 70	7	61 – 70	7	61 – 70	7
71 – 80	8	71 – 80	8	71 – 80	8	71 – 80	8	71 – 80	8
81 – 90	9	81 – 90	9	81 – 90	9	81 – 90	9	81 – 90	9
91 - 100	10	91 - 100	10	91 - 100	10	91 - 100	10	91 - 100	10

4. Conclusion

Flood management measures should be identified based on proper flood risk assessments, but there is no such practice in the field with having no applicable flood risk assessment method. Further, the authorities state that the lack of funds and other resources have also affected not to conduct flood risk assessments periodically. Therefore, such a simple flood risk assessment method can be used with a minimum cost using the available human resources and existing data.

5. Key Words

Exposure, Flood risk assessment, Hazard, Vulnerability

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