Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 212 (2018) 503–510

Procedia Engineering

www.elsevier.com/locate/procedia

7th International Conference on Building Resilience; Using scientific knowledge to inform policy and practice in disaster risk reduction, ICBR2017, 27 – 29 November 2017, Bangkok, Thailand

Qualitative Flood Risk assessment for the Western Province of Sri Lanka

Kumari M. Weerasinghe[a]*, Hans Gehrels[b], N.M.S.I. Arambepola[c], Hari Prasad Vajja[c], J.M.K. Herath[a], K. B. Atapattu[a]

[a]*Central Engineering Consultancy Bureau, Colombo, Sri Lanka*
[b]*Deltares, Delft, Netherlands,*
[c] *Asian Disaster Prevention Centre, Bangkok, Thailand;*

Abstract

The Western Province of Sri Lanka, is comprised of the 03 most densely populated districts, and is home to the administrative and business capital of the country. The Province contributes the highest share, around 41.2%, to the GDP. The mega scale development projects implemented in this province are often challenged by urban flooding, which is caused by heavy rainfall coupled up with urban expansion, deficiencies in the drainage systems, insufficient retention capacity etc., and there is a prioritized need to reduce the impact of floods. This paper presents the results of a qualitative flood risk assessment at the scale of Grama Niladhari (GN) Division, which is the lowest administrative unit in the country. The essence of the method applied for delineating the combined flood risk levels is a statistical expression of hazard, exposure and vulnerability. Three types of vulnerabilities, namely, social, economic, and physical (housing), have been considered. The results influence to conclude that the flood risk of population is more sensitive to economic vulnerability than to social vulnerability; also that the type of housing units is a reasonable indicator for assessing the risk of housing. The application of risk information in the decision making process reduces the future flood risk as it allows integration of flood mitigation options during development planning, reduce the vulnerability of population and allocate sufficient funding for relief and rehabilitation.

*Keywords:*Regional scale flood hazard analysis; Qualitative flood risk assessment; Simplified exposure and vulnerability assessment

* Corresponding author. Tel.: +94-71-444-3413; fax: +94-11-2598215.
*E-mail address:*kmweera@yahoo.com

1877-7058 © 2018 The Authors. Published by Elsevier Ltd.
Peer-review under responsibility of the scientific committee of the 7th International Conference on Building Resilience
10.1016/j.proeng.2018.01.065

1. Introduction

Understanding the flood risk of low lying land is highly important in decision making on sustainable development, planning and design of necessary interventions and/or for allocation of funds for flood risk reduction. According to Blaikie et.al. [2], analyzing disaster risks shows how they can be professed within the society at large, and more fruitful ways of building policies to reduce disasters and mitigate hazards, while improving the living standards and opportunities more generally. Bendimerad [1] highlights the importance of risk assessment as it produces technical information for the identification of hazardous areas, and serve in formulating zoning regulations, establishing population density levels, and to design necessary mitigation actions to reduce hazard risk.

Where the sufficient data required for a quantitative risk assessment are not available, a qualitative approach combined with statistical analyses of the elements contributing to risk can serve as a comparative statement on flood risk. The essence of the method is a statistical expression of hazard, exposure, and vulnerability combined for expressing the flood risk levels at the scale to which the data are available. Flanagan et al. [4] highlights importance of using a geographic scale sufficient to discern demographic differences. This qualitative flood risk assessment is performed at the scale of Grama Niladhari (GN) Division, which is the lowest administrative unit in the country.

The selected study area extends to the outskirts of Colombo City, the Business Capital of Sri Lanka, and encompasses the land identified for mega scale developments under the Megapolis and Western Development Plan implemented by Sri Lanka. Majority of the study area is densely populated and subjected to flooding or inundation due to heavy precipitation and has potential for incurring direct losses and damages. The Metro Colombo basin and the Kolonnawa basin which are located within the selected area possess the required detailed information and therefore, a quantitative flood risk analysis has been performed for the said two basins [8]. The area beyond the referred two basins has been considered for constructions of technology cities, industrial parks, educational hubs and associated infrastructure development projects, however, the data required for a quantitative flood risk assessment are not readily available for the said area. Acquiring necessary data for deriving high resolution digital elevation models, buildings and infrastructure footprints, and for developing hydrodynamic flow models are costly, time consuming and impossible to make available prior to the implementation of planned developments. Therefore, the objective of this study is to assess the hazard potential, exposure of elements, and their vulnerability by using the readily available climatological, topographic and census (2012) data, and to assess the flood risk of the referred study area, which has been considered for rapid and large scale developments. This paper presents the techniques utilized for assessing the hazard, exposure and vulnerability for evaluating the flood risk of population and housing.

2. Flood Hazard Assessment

Information on topography, rainfall intensity, land cover, and geology were used to assess the flood hazard [8]. The “FIGUSED” model (Fig. 1), introduced by Kazakis et al. [6], was used for analyzing the hazard indices, at GN Division level, for the selected study area.

2.1. Input Parameters

Flow accumulation (F), rainfall intensity (I), geology (G), land use (U), slope (S), elevation (E), and distance from drainage network (D) were the input parameters. Data collected from different sources were processed and reclassified (Table 1) on a GIS platform for generating individual thematic maps. DEM derived from Shuttle Radar Topographic Mission (SRTM) at 1 Arc-Second (30 m) global data was used for generating flow accumulation, slope and elevation thematic maps. Modified Fournier Index (MFI) was calculated at each rain gauge station within the study area, and spatially distributed using Inverse Distance Weighted (IDW) interpolation method for generating the thematic map of rainfall intensity. The land use map with 57 land use categories was collected from the Land Use Policy Planning Department (LUPPD) of Sri Lanka, and reclassified into 5 land use classes, based on their hydrological significance. The geology map published by the Geological Survey and Mines Bureau (GSMB) was reclassified using the hydro-geological properties of surface soil/rock type. Distances from the drainage networks were derived by generating buffer zones at selected distances (Table 1) on the Arc GIS platform [8].