Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 212 (2018) 22–29

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

Study on housing units locate in very high and high landslide hazard prone areas of Hali-Ela divisional secretariat division, Sri Lanka

Jude Prasanna[a*] & Winson Gnanatheepan[a]

[a]*National Building Research Organisation, Sri Lanka*

Abstract

Landslides are one of the major natural disasters that occur in Sri Lanka resulting in loss of lives and severe damages to livelihoods and property. Landslide hazard mapping project was launched to study and identify the distribution of landslide potential in central highland of Sri Lanka. Spatial distribution of risk buildings locate in very high and high landslide hazard prone areas are being identified through 1:10,000 scale landslide hazard maps prepared for the lowest administrative units called Grama Niladari Divisions. A building survey is carried out in housing units, commercial/institutions, religious places and schools, which are located in very high and high hazard landslide prone areas of the Badulla District. This paper presents the results of the building survey carried out in housing units locate in very high and high landslide hazard prone areas of Hali-ela D.S Division in the Badulla District. The empirical evidence revealed ten pertinent issues, livelihood of the families rely on lands in landslide prone areas; designing of houses without professional support; construction of houses without approval obtained from relevant authorities; construction of houses without obtaining landslide clearance certificate; construction of houses on steep slope (>31°) terrain; change of land morphology for construction of houses; presence of tell-tale landslide signs at the vicinity of houses; having no drainage system to discharge rain water; possibility of access road to the settlement damage by disaster; inadequate instructions to inhabitants on disaster preparedness; and housing units built without the support of professionals, to protect against landslide hazard and reducing landslide disaster risks.

Peer-review under responsibility of the scientific committee of the 7th International Conference on Building Resilience.

Keywords: Landslide; risk buildings; building survey; housing units

1. Introduction

A landslide is a downward or outward movement of soil, rock or vegetation, under the influence of gravity. This movement can occur in many ways. It can be a fall, topple, slide, spread or flow. The speed of the movement may range from very slow to rapid. The mass of moving material can destroy property that is along its path of movement, and cause death to people and livestock. The central highlands of Sri Lanka often experience landslides during the rainy seasons (Ministry of Education and National Institute of Education, 2006) [1]. Although landslides had been traditionally considered as a minor type of disaster and not a common occurrence in Sri Lanka until the year 2002, a sudden increase in the occurrence of landslides during the years 2003 – 2008 can be observed (Disaster Management Centre & UNDP, 2009) [2]. Of the 65,000 Sq.km of land extent of Sri Lanka, nearly 20,000 Sq km encompassing 10 districts is prone to landslides. It is about 30% of Sri Lanka's land area and spread into several districts, namely, Badulla, Nuwara Eliya, Kegalle, Ratnapura, Kandy, Matale, Kaluthara, Mathara, Galle and Hambantota

* Corresponding author. *E-mail address:* judep1985@gmail.com

1877-7058
Peer-review under responsibility of the scientific committee of the 7th International Conference on Building Resilience
10.1016/j.proeng.2018.01.004

(Bandara, 2005) [3]. These landslides cause much damage to both human lives and built environments. In January 2007, over 450 families in the Hanguranketha and Walapane divisions were displaced due to a series of landslides (Ganepola, 2009) [4]. From year 2000 to 2010 lives lost due to landslides amount to 351 and houses damaged and destroyed due to landslides amount to 9468 (Ministry of Disaster Management, 2014) [5]. The landslide that occurred in May 2016 in the Kegalle district was tragic as it took the lives of 52 people and fully damaged 168 houses in the slope region (Vijekumara and Weerasinghe, 2016) [6].

The National Building Research Organization (NBRO) is the mandated agency for landslide risk management in Sri Lanka functioning under the Ministry of Disaster Management. NBRO is carrying out landslide hazard mapping project covering 10 landslide prone districts in Sri Lanka to identify areas susceptible to landslide hazard. Based on landslide hazard zonation maps, the landslide risk profile development project is implemented since 2016. The objective of this project is to develop Divisional Secretariat level landslide risk profiles and to develop a spatial database of risk communities which will be incorporated into development planning process. Spatial distribution of risk buildings located in high landslide hazard area are being identified using 1;10,000 scale landslide hazards maps prepared for the lowest administrative units called Grama Niladari Divisions with the use of ArcGIS software. A building survey is carried out in housing units, commercial/institutions, religious places and schools, which are in very high and high landslide hazard prone areas of the Badulla District. The purpose of the survey is to collect information characteristics of the inhabitants, characteristics and use of the buildings etc. Within this context, the scope of this paper is to explore the results of the survey carried out in housing units in very high and high landslide hazard prone areas of Hali-ela Divisional Secretariat Division in the Badulla district.

2. Methods of data collection on building at risk

Risk assessment includes the process of risk analysis and risk evaluation. Risk analysis generally contains; analyze the risk, identify and measure the frequency, magnitude, and type of hazard and the vulnerability and exposure of the elements at risk. Buildings are one of the main groups of elements at risk at hazardous event. It comprise the inhabitants and the properties accommodate in the buildings. Behavior of a building under a hazard event, determines whether the inhabitants in the building might be injured or killed by the occurrence of hazardous phenomena. In order to assess the potential losses and degree of damage of buildings that are exposed to a certain type of hazardous event, it is important to define the characteristics of the building.

Elements at risk are the population, properties, economic activities, including public services, or any other defined values exposed to hazards in a given area. The interaction of elements at risk and hazard defines the exposure and the vulnerability of the elements-at risk. Exposure indicates the degree to which the elements at risk are exposed to a particular hazard. Although elements at risk information may be derived from existing data sources such as census data, there is always a need to collect additional information to characterize the elements at risk for estimating the vulnerability. For collecting information on building types, construction materials, land ownership, and the checking of urban land use, normally stratified samples are taken, as it is often too time consuming to do a complete house-by-house survey (Westen. *et.al*, 2011) [7]. The procedure adopted to obtain the elements at risk varies for local and regional scale analysis. Obtaining the elements at risk and quantifying vulnerabilities in large regions is generally a challenging issue. In large regions the elements at risk has been obtained by overlaying the hazard maps with land cover maps and the extracted elements were classified into different categories in order to differentiate the exposure of different types. In addition, the population data is derived from existing census data (Erener, 2009) [8]. Identifying the elements at risk of landslide and vulnerability assessment need the exact spatial distribution of buildings in the study area, as well as the socio-economic information like the number of stories, possession of properties, economic values etc. All of the data considered as elements at risk are basically extracted from cadastral data and participatory GIS procedures (Gaprindashvili. *et.al*, 2014) [9]. Building information can be obtained in several ways. Ideally, it is available as building footprint maps, also be derived from databases. If such data are not available, building footprint maps can be generated using screen digitisation from high-resolution images, or through automated building mapping using high-resolution multispectral satellite images and LiDAR (Corominas, 2013) [10]. This study has gone through methods employed in earlier studies to collect information on characteristics of the buildings and socio-economic information of the inhabitants accommodate in risk buildings. From the above literatures it is revealed, following methods; 1) stratified samples 2) house-by-house survey 3) participatory GIS procedures 4) building footprint maps are employed to acquire socio-economic information of both the buildings and inhabitants accommodate in risk buildings. After reviewing methods, this study apply house-by-house questionnaire survey method for data collection due to; (1) limitations in GIS-based approaches in relation to availability, quality, and scale of the digital data (2) non availability of spatial reference in available census data (3) advantage of using house-by-house questionnaire survey for accurate data collection directly from the occupants.

3. Study area and the method of study

The study area has been taken as Hali-ela Divisional Secretariat Division (DSD) in the Badulla district, Sri Lanka. Hali-Ela DSD is located 6 km from the Badulla Town, the capital city of the Badulla district. Total land area of Hali-ela DSD is 156.77 km^2 (15,677 ha), which is 5.6% of the total land area of Badulla District. According to the national grid it is located 185-206 to the North and 219-239 to the East. It is also situated between 6.50-7.10 Northern longitudes and 80.50-81.10 Eastern latitudes. Hali-ela DSD which is located in the middle of the Badulla District, consisting 57 Grama Niladhari Divisions. Landslide history of Hali-ela has been recorded since 1986 to 1990. According to Disaster Information Management System of Disaster Management Centre,