Abstract

Landslide Hazard Mapping and Risk Assessment Using GIS. Case of Nyabihu District, Rwanda

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This research adopted the classification by rating and fit to be weighted overlay. During data analysis, different factors were classified according to rating and assigned to each factor causing landslide. A rating between 1 and 3 was assigned to each factor. This introduced, after the classification of all key factors, each factor was assigned a weight depending to its own level of potential influence to cause landslide. The landslide hazard map was classified into five hazard zones. High landslide hazard zones are very prone to landslides, medium landslide hazard zones are prone to landslides, low landslide hazard zones are less prone to landslides, lowly landslide hazard zones are very less prone to landslides, and very low landslide hazard zones are not prone to landslides. The results were verified by referring to the literature research and the information gathered on the field. During assessing risks in Nyabihu District, 90 Schools have been assessed and 88 highly exposed, 2 moderately exposed. Total 516 roads found 53.3% are in high danger while 46.7% low and moderately low exposure. 38.4% population of Nyabihu are in high risk zone exposed to landslide especially Bigogwe, Nkurabwa, Mutambwa and sitesa sectors of Nyabihu.

Keywords: landslide, landslide hazard, landslide risk assessment, risk map, GIS

Methods and Materials

One of the major concerns of this study was to analyse the key factors or parameters causing landslide in Nyabihu District. Specifically the research focused on five parameters namely rainfall, soil type, land use, elevation and topography. The landslide was classified into six classes: high, moderate, low, very low, extremely low and no landslide. The research was done on the Nyabihu District, Rwanda. The site was chosen because it is one of the high landslide risk areas in the western part of the country, and Nyabihu District is one of the high landslide risk area in the country.

Introduction

Landslides are one of the most dangerous hazards in the world which mostly affect the natural environment and human activities (Bjerga & Flåkger, 2016). Nyabihu district lead to severe loss of lives, caucucess as well as the destruction of social and economic activities in different areas of the district; more importantly, the localized disasters cause frequent disturbance, changes in water levels, and various human activities such as deforestation, human activities, infrastructure developments, forest activities, human activities. By mining have been considered as the most crucial agents to the landslides.

The Sub-Saharan Africa where Rwanda and other large parts of Eastern Africa are located, is a region which historically experiences natural hazards including landslides at a higher level compared to Western parts of the continent where the hazard is at a lower level or occurrence. Landslide hazards occurring in the region are mainly caused by heavy rainfall, steep slopes, soil type and deformation. In the Western part of the country, landslides occur at Nyabihu District, Rwanda. The landslides in the district are caused mainly by heavy rainfall, steep slopes, and the high gradient topography. The Nyabihu district is located within the Nyabihu Sector in the Nyabihu District. The district is administrative within the regional government called for an immediate risk assessment away from mountain areas. (Nyabihu, 2013)

Geographically, the relief of Nyabihu is rugged mountains with more than 50% of the total area covered by steep slopes. It receives an annual rainfall of 1500-2000 mm annually which supplies adequate water to the soil erosion which result into the destruction of both human activities and its environment (Nyabihu, 2013). The total population in nyabihu district is 34,012, and 3,041.12 km² of land area is covered by valley bottoms, floodplains, and alluvial fans by topographic characteristics by steep slopes which are often affected by landslides during rainy seasons (WIDRAM, 2015).

Nyabihu district is one of 7 Districts that make up the Western Province of Rwanda. It neighbors Rubavu district on the West, Ruhengeri on the South, Gisonge on the East, Musanze on the North East, Nyanza on the South, and Nyanza on the South West. The district comprises of 12 sectors subdivided into 73 cells and 473 villages, with the population density estimated to be 551 inhabitants per square kilometer. Nyabihu, 2013. Jinjo and Bugabo sectors are the most populated sectors in the region. Sector like Musanze, Jinjo, and Jinjo are the only urbanized areas in the district (MBA, 2012).

Nyabihu is a district and administrative in which the Nyabihu sector is the most populated sectors. The Nyabihu sector is the most populated sectors in the region (Nyabihu, 2013). The Nyabihu sector is the most populated sectors in the region (Nyabihu, 2013). The Nyabihu sector is the most populated sectors in the region (Nyabihu, 2013).

The quantification of the three kind of selected elements namely social, school, (Kintobo, 2012) and physical/infrastructures and populations number has been taken into consideration on the basis of each sector of Nyabihu district.

Each element categorized into ranges each with three classes and assigned different values 1.2.3 representing sector with low, moderate, high risk respect to methodology through method known as rating. Rating and ranking were calculated according to the number or quantity of selected elements available in each sector by ensuring the balance between elements being low, moderate and highly affected.

Discussion

The aim of this research was to design a feasible platform and roadmap for landslide occurrence and risk assessment for area prone to landslides in Nyabihu district. The study analyzed the effective mapping of areas with high susceptibility to landslide in the district. This was achieved by referring to the literature research and the information gathered on the field. During assessing risks in Nyabihu District, 90 Schools have been assessed and 88 highly exposed, 2 moderately exposed. Total 516 roads found 53.3% are in high danger while 46.7% low and moderately low exposure. 38.4% population of Nyabihu are in high risk zone exposed to landslide especially Bigogwe, Nkurabwa, Mutambwa and sitesa sectors of Nyabihu.

The area is highly prone to landslide hazard which is high risk and low exposure. For the same reason, the whole of Nyabihu, Jinjo and Jinjo sectors have been categorised in 90%, Bubanza, 5% and Dageza, 2% which are very high risk and low exposure. The study revealed that every area of the district falls into different landslide category comprising very high, high, moderate and low danger. It was found that areas of South-East of the district is highly vulnerable and prone to landslide occurrence, 7.6% of the study area. Three classes of landslide risk are high, moderate and low respectively. In total 516 roads found 53.3% are in high danger while 46.7% are low and moderately low exposure. Total 516 roads found 53.3% are in high danger while 46.7% are low and moderately low exposure. Total 516 roads found 53.3% are in high danger while 46.7% are low and moderately low exposure. Total 516 roads found 53.3% are in high danger while 46.7% are low and moderately low exposure. Total 516 roads found 53.3% are in high danger while 46.7% are low and moderately low exposure.

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