The Impact of Landslide on Environment and Socio-Economy: GIS Based Study on Badulla District in Sri Lanka

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ABSTRACT

A disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. All over the world the impact of disaster is very challengeable. Sri Lanka is not except for it. Landslide, flood, tsunami, drought and accidents are in abundance. Considering the Landslide, Badulla District is often affected by the landslide disaster. Thus, this study aims for this study, primary and secondary data were used. MS Excel 2013 and Arc GIS 10.4 were used to analyze the study. The findings of the study, the cause of physical factors around 40% and around 60% of causes occurred by human factors of landslide. Identify the landslide area measures the landslide, collecting the reports of infrastructure and precautions of landslide are supporting to reduce the effect. When shows the maps using GIS technologies for this landslide area helping to move the people to safe zone. Depth roots plants should be planted in this area to capture the soil and rock that will prevent the slide. Reservoirs must be built after doing the geological examination and geomorphological examination. Using the screed concrete in the base of mountains and making the Gabion walls of the width and height of mountains help to prevent the slide. This method called Geo textile. These solution helps to control the effect from landslide.

Keywords: Disaster, Landslide, Gabion Walls, Geo textile
1. INTRODUCTION

Disasters are occurring on the earth when the organism formed that is the occurrence of the abnormal changes on the lithosphere, hydrosphere and atmosphere. Disasters have an important impact on development. They disrupt livelihoods, cause loss of human lives and damages to properties and infrastructure are estimated to cost around USD 250 billion worldwide each year.

In addition, landslide is ‘sudden slide or move or fall or flow or lateral spread of the highland, soil, clay, rock, mass or mud by the natural or human causes. The major problem what making damages in each year in the highland is the landslide disasters.

Thus, the major landslide in the world was occurred beyond Africa around the extent of 20000 Km that is Alhaz landslide. Thereafter, many landslides were occurred in different zones and different time. Considering koslantha Nagadiya landslide occurred in October 1997 and Meeriyapeththa landslide in October 29th, 2014 were highly impact on the environment and socio economy. So, the valuable source is land should be conserved by every generations for the sustainable development.

2. STUDY AREA

![Figure 1. Study Area](image-url)
Badulla District is situated in the Uva province between 6° 59’ 05” of North latitude and 81° 03’ 23” of the East longitude of Sri Lanka. The extent of this district has 2861 km². Its annual average rainfall is 2000 mm and the temperature is 20 to 25 ºC. The rainfall varies in North and South part of the District around 2500 mm and in Uva region it is approximately 1700 mm. It has been 15 Divisional Secretariat and 567 Grama Niladhari Divisions. Its population is 837000.

3. OBJECTIVES

Main Objective
- Identifying the causes of the landslide in Badulla District.

Specific Objectives
- Identifying the changes of landslide between 2011 and 2016
- Finding the environmental and socio-economic impacts
- To propose the solution to lessen the impacts

4. MATERIALS AND METHODS

Primary and Secondary data were used to collect the qualitative and quantitative information.

Primary Data
It had been gathered through the observation, group discussion, direct interview and field visit. Landslide occurs in 14 Divisional Secretariat Divisions out of 15 Divisional Secretariat Divisions. In case, group discussion has been done with 50 affected people, 15 landslide related organizational officials, 5 Grama Niladharies, 14 Divisional Secretariat and 16 Disaster Management department officials.

In addition direct interview has been done with 21 heads in the study area.

Secondary Data
It has been collected from published and unpublished data source. Previous research articles, DS Division reports, Internet, Statistical reports, Disaster Management Department reports, Magazine, Newspapers, Topographic map and Satellite images are the secondary data.

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All the gathered information had analyzed using MS Excel 2013 and Maps were drawn using Arc GIS 10.4.
5. RESULT AND DISCUSSION

Badulla District often fall in landslide in Sri Lanka. Meantime, many places in this district expect the landslide. It proved during the field survey which had for the study purpose.

![Landslide status in study area 2016](image)

**Figure 2.** Landslide status in study area

According to the graph 80% of people told, there is highly landslide occurred and sometime 20% opposed this comments. Moreover, it found that the causes which for landslide in this area.

![Causes of Landslide](image)

**Figure 3.** Causes of Landslide

By this graph, the cause of physical factors around 40% are that heavy rainfall, topography, rock nature, natural current, natural vegetation, natural watershed and soil erosion
such kind of reasons. Around 60% of causes occurred by human factors that is improper landuse, turning the runoff, unplanned infrastructure, improper cultivation, deforestation, Chena cultivation, making roads and dams.

![Physical factors for landslide](image)

**Figure 4.** Physical factors for Landslide

According to the field survey the below physical factors were found out in the study area.

**Heavy rainfall**

![Monthly rainfall in Badulla District 2014](image)

**Figure 5.** Monthly rainfall in Badulla District 2014
Around 31\% of physical factors for landslide were determined by the rainfall found during the field visit. This area got almost 2500 mm rainfall. One of the factor of Meriyapeta landslide was the rainfall above 400 mm got by the study area in 2014, October.

In addition a landslide formed in Kumpalwela and Thodangola areas because of the high rainfall around 669.5 mm in 2014, December and Badulla to Bandarawala main street, Lunugala, Haputale, Thalungotuwa and Inigmebeta areas often affected due to the rainfall around 75 mm per hour or above 100mm per day.

**Soil Nature**

Colluvium soil contains approximately 2 m to 10 m density in Meriyapeta that severe erosion cause to the landslide in 2010, October 29\(^{th}\) and still has the rock movement in this area.

**Topographic form**

The study area landscape is highly depending on the landslide. Around the 17\% of landslide is formed by the landscape. This landscape observed with 2D and 3D map which made using Arc GIS for 14 DS Divisions.

**Figure 6. 2D Topography map of Haputale DS Division**

Haputale area located in 1940 m above the sea level. Its lowest height is 880 m. The central part of the South Eastern area is 1400 m hill area. Uma Oya and Valley Oya flow in the Southern part.
Figure 7. 3D Topography map of Haputale DS Division

Eastern slope is mostly hilly area in Haputale.

Figure 8. 3D Topography map of Badulla DS Division
Badulla DSD situated in 1800 m above the sea level. Its lowest height is 520 m. The end of the South Eastern area is 1200m upper hill land area and Bathulu Oya flows in this region.

**Figure 9.** 3D Topography map of Badulla DS Division

The 3D image show that the South Eastern slope is the highest upland area.

**Figure 10.** 2D Topography map of Bandarawala DS Division
Bandarawala DSD is in 1940 m above the mean sea level. Its lowest height is 580 m and this area has Uma Oya river basin.

Figure 11. 3D Topography map of Bandarawala DS Division

Kandaketiya DSD located in 1540 m above the sea level and the lowest area of this is 100m and the highest area 800 m is the highland area in the Southern part. Uma Oya and Badulu Oya are following in this area.

Figure 12. 3D Topography map of Kandaketiya DS Division
Ella DSD is situated in 1700 m above the mean sea level. Its lowest height is 100 m. Kirindi Oya flows in this region.

Figure 13. 3D Topography map of Ella DS Division

Haldumulla DSD is located in 2200 m above the sea level. Its lowest height is 200 m and Valley Oya in North western region, Kirindi Oya in Eastern region and Kuda Oya in South Eastern region of this division are flowing here.

Figure 14. 3D Topography map of Haldumulla DS Division
Welimada DSD is situated in 2340 m above mean sea level. The lowest area is 200 m and Uma Oya flows in Eastern and Central part of this area.

Figure 15. 3D Topography map of Welimada DS Division

Passara DSD is located in 1980 m above the sea level. The lowest height is 200 m and Kumukan Oya in Northern part and Menik Ganga in Eastern part are flowing in this division.

Figure 16. 3D Topography map of Passara DS Division

Human Factors for Landslide

There are many factors causing to the landslide identified through the direct interview.
6. CONCLUSION AND RECOMMENDATIONS

The physical factors what reasons for the landslide are topographic form, rock type, barrier in water flow, natural current, soil erosion and natural vegetation cover. The human factors of landslide are improper landuse, improper infrastructure, deforestation, Chena cultivation, transport development.

The landslide severity increased from 2011 to 2016. Therefore, there are some following solutions proposed to reduce the landslide issues.

- Identify the landslide area measures the landslide, collecting the reports of infrastructure and precautions of landslide are supporting to reduce the effect and can be move the people to safe zone.
- When shows the maps using GIS technologies for this landslide area helping to move the people to safe zone. By this map, can be identify the landslide zone, safe zone, exiting way, etc. and also can be done the awareness programmes using this maps.
- Depth roots plants should be planted in this area to capture the soil and rock that will prevent the slide.
- Reservoirs must be built after doing the geological examination and geomorphological examination. It should do after getting EIA approval.
- Using the screed concrete in the base of mountains and making the Gabioin walls of the width and height of mountains help to prevent the slide. This method called Geo textile. Gabioin Walls
• During the awareness programme to the students, planners, administrators, decision makers, Grama Niladhari and people will help to control the effect from the disaster.
• Encourage the people to do the Terrace / Furrows Farming system.

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Figure 18. Gobion Walls


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(Received 07 October 2017; accepted 25 October 2017)