

# **Importance of Planning Guidelines in Landslide Disaster Risk Reduction**

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## **Abstract**

In the recent past, it is noted that a increasing trend of occurrence of natural disaster in Sri Lanka. It is also further noted that the intensity and frequency of the natural disaster have increase. Among them, the most threatening disasters in hilly areas are slope failures and landslides.

Landslides were previously perceived as isolated events which occurred mainly due to natural causative factors with low vulnerability. However, rapid population rise, inappropriate, development trends, degradation of forests and natural resources in steep slopes have contributed to intensified occurrence of landslides. Studies of National Building Research Organisation (NBRO) have revealed that nearly 70% of the landslides in Sri Lanka are human induced. Landslides in areas with unplanned human settlements has increased the vulnerability in terms of loss of life, damage to property, disruption of livelihood, damage to infrastructure and lifeline facilities of environment.

Poor consideration of these causative factors by design makers in local planning process such as, enforcement of land use planning guidelines and related practices in landslide prone areas have significantly contributed to increased hazard and vulnerability. NBRO's studies have further shown that weak governance and low level of awareness are major problems faced by authorities and decision makers in planning human settlements in the central hills, especially in the areas identified as landslide prone.

This paper presents the issues and findings related to development of unplanned human settlements and current planning applications of the local authorities in hilly areas to mitigate landslide risk. Paper further examines the benefits of integrating landslide risk reduction in a national policy and role of local governments. This paper also explain how structural mitigation with effective land use planning practices can be used in achieving planned development through the knowledge transfer from research institutions to implementation agencies.

## **1.0 Introduction**

Sri Lanka is prone to both natural and human induced disasters. Droughts, landslides, cyclones, wind storms surge, Tsunami and Coastal erosion are the disasters that occur due to natural phenomena. The man made activities have aggravated the vulnerability of the natural phenomena to human settlements. Disasters resulting from direct initiation of man are terrorism, civil conflicts, explosions, industrial accidents, epidemics, fires and deforestation that affect the people of the country.

Landslides are a natural phenomenon of stability which occurs as a result of causative factors such as rain fall (direct and indirect effects) underlying geological formation, rock type, slope angle, weathering of the rock, joint pattern, soil type etc.

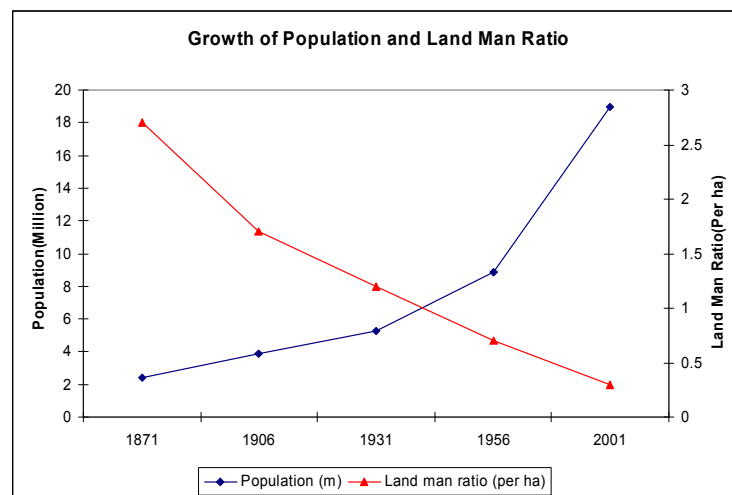
Human activities such as land use, use of problematic areas for development are some of the factors that aggravate landslide. Population in landslide prone areas has increased in the past considerably. Following table shows the details of populations, land area and densities in landslide prone districts of Sri Lanka.

**Table 01. Population Density in Landslide Prone Areas**

District	Land Extent (sq.km)	Population 1981	Population 2001	Population Density (sq.km) 1981	Population Density (sq.km) 2001
Nuwara Eliya	1741	603577	70083	347	402
Kandy	1935	1048317	1272463	541	658
Badulla	2961	640952	774555	224	268
Kegalle	1692	684944	779774	405	460
Ratnapura	3275	797087	1008164	243	308
Matale	1993	357354	442421	179	222
Kalutara	1597	829704	1060800	519	664
Matara	1282	643786	761236	510	594
<b>Total in identified Landslide prone areas</b>	<b>16376</b>	<b>5605721</b>	<b>6795502</b>	<b>341</b>	<b>415</b>
<b>Sri Lanka</b>	<b>65525</b>	<b>14846750</b>	<b>19000000</b>	<b>226</b>	<b>289</b>

Source : Based on Department Census and Statistics data

**Fig 1.1**



**Fig1 Growth and population of land man ration**

Source: Department Censes and Statistics data

Out of 25 administrative districts in Sri Lanka ten (10) districts are prone to landslides namely Nuwara Eliya, Badulla, Kegalle, Kalutara, Kandy, Matale and recent time of Matara, Galle and Hambantota. The above mentioned landslide prone area covers approximately 30% of the total land area of the island, and it is occupied by about 35% of the population of Sri Lanka. Landslide density is occurring in these districts are at 1-2 per sq.km. Trend analysis by NBRO researchers reveals an acceleration of landslide occurring in Sri Lanka.

**Tabl 1.2. Reported Number of Landslide and Cutting Failure-2006**

District	Landslide	Rock fall	Activation of Old landslide	Cutting failure
Kandy	07	-	-	54
Kegalle	11	-	-	04
Badulla	09	01	02	22
Matale	03	01	-	10
Kalutara	-	-	-	05
Matara	03	01	-	10
Ratnapura	03	01	03	02
Gampaha	-	-	-	06
Colombo	-	-	-	03
<b>Total</b>	<b>06</b>	<b>04</b>	<b>05</b>	<b>116</b>

Source: National Building Research Organisation.2007

The increased human intervention on hill slopes has direct relationship to increased frequency and intensity of landslides. The human interventions significant for landslides are improper land use practices such as unplanned settlements without access (Suduhumpola Kandyfig 2 ); disturbance to the natural drainage (Kandopla); cultivation in steep slopes (Welimada); non engineering construction (Bandarawela), blocked natural draining paths, cutting and filling of slope, back water leaks from irrigation canals; mining and quarrying causing artificial vibration, and construction of highways without taking account on previous landslides.(sites with previous landslides are liable to repeated landslides events.)

Landslide disaster being significant economic and social impacts; sever damage to life and property, physical environment and socio economic life of the society. The increased frequency and magnitude of these events has caused loss of many lives, property and even damaged the natural environment.

## **2.0 Human Actions Aggravating Landslide Hazard**

### **2.1 Unplanned Human Settlements Activities**

The studies shows that unplanned housing schemes, resettlements and settlement programs, construction and land development activities without proper planning and technical guidelines, has a direct link to the occurrence of landslides and reactivation of old landslides.



**Fig 2 Landslides in Suduhumpola Kandy**

In recent times the threat of landslide looms largely over densely populated urban areas in the hilly areas of Sri Lanka. The threat has been increased due to unplanned human activities. About 35 large and medium sized towns in central highland are threatened with landslide. Inadequate drainage in buildings, cut slopes and fills or blocking of contour drains increasing the infiltration of runoff which was previously distributed over the slope. The surveys revealed that Local Authority of the Sabaragamuwa Provincial Council of which many areas are prone to landslide hazard, nearly 79% land did not have a land use zoning plan and only 21% have land use zoning plan. Land extent of most of these houses is between 2-8 perches. Due to these reasons they are located very close to each other on steep slopes.

### **2.2 Clearing of Plantation**

As a result of population growth in the hill districts, people moved to marginal land which is not suitable for residential purpose. The uplands are cleared for more attractive short-term cash crops and vegetable gardens, housing and for the construction of roads. Larger extent of tea, rubber plantations (perennial crops) had been cleared specially in Kalutara, Ratnapura and Matara Districts for various development activities or in shifting cultivation and varies plantation. The uprooting of rubber tress results in creating loose soils and thereby increases in water infiltration. The poor water management low country tea plantation is also a contributory factor for unstable slopes and landslides.

### **2.3 Sand Mining and Construction**

Problems related to instability of river banks due to bank erosion and haphazard sand extraction on river beds in hilly areas creates landslide banks failure and land subsidence.

Due to construction industry boom in late 90's and early 2000 extraction of sands has increased. With the current weak regulatory setup many riverbeds have become an attractive spots for illegal sand mining. Sand mining in areas with steep slopes can create bed scouring, siltation, change of river

morphology, bank erosion, and then can trigger landslides. The landslide in May 2003 at Kahawatta is due to uncontrolled sand mining and gem mining in "We Ganga."

## 2.4 Commercial Agriculture

Growing vegetables on slopes in upcountry is a good profit making activity currently. (fig 3 ). To water them, small reservoirs are built in hilly slopes and water is supplied from irrigation channel systems. These small reservoirs and channels are prepared in unplanned manner hence that promotes water to leach to hilly slopes frequently. Due to and marginal lands are converted to commercial agricultural purpose. Hilly slopes have become unstable for cultivation. Most areas at Kadapola of Nuwara Eliya already face this problem and they have already been categorized as high risk in terms of landslide threat.



Fig 3 - Tea lands converted to vegetable cultivation in Ragala

## 2.5 Gem Mining

Irregular gem mining in the Ratnapura District is a critical environmental issue thereby creating a increased landslide threat in steep slope. During gem mining, mines are burrowed under the ground, and soil is taken out. The burrowed pit is not filled at the end, and also the gems extraction process is linked with excessive use of water. The mining process results in land subsidence and also turbidity in natural water. The secondary hazards linked with gem mining are landslides, soil erosion, mosquito menace, alteration of riverbed morphology due to sediment runoff and sometimes lowering of ground water table.

## 2.6 Deforestation and Forest Fires

The degradation of forest cover due to forest fires in the upper watersheds is a growing concern due to its nature and extent. Forests are set on fire by people as a method of clearing land for agriculture, to catch wild animals and by pure negligence. The fires destroy the ground cover while damaging the most important ground hold capacities. These results in poor water retention, affect natural soil water balance, trigger erosion hazards and intensify runoffs which help the triggering of landslide.

Deforestation has increased dramatically during the 20<sup>th</sup> century due to spread of plantation, agriculture, large-scale development projects and illegal felling of trees for commercial purposes. Annual rate of deforestation is about 25,000 ha in the country. Highest rate of deforestation have mainly occurred during 1956 to 1996 at the rate of 40,000 ha per year as a result of accelerated Mahaweli development program.

The “ecological stability” will be affected due to removal of trees and forest cover result in soil erosion, depletion of soil fertility, landslide, downstream flooding, and effects on wild life.

## **2.7 Road Construction**

Although constructions of new roads require Environment Impact Assessment (EIA), road widening does not require the impact assessment. However, it has been observed that most earth slips or bank erosion has taken place where road widening has happened. Ex: Gampola Nuwara Eliya road. (fig 4 )

Landslides have triggered during or after road construction due to the following reasons.

- (i) The loss of lateral support and the other causes discussed under the effect of cuts and excavations
- (ii) Increase of surcharge particularly from a loose fill on downhill side of the slope
- (iii) Lack of proper drainage disturbance to natural drainage paths, or due to inadequate maintenance lead to water infiltration.
- (iv) Additional surcharge due to vehicles
- (v) Road construction based on unplanned development on the slope



**Fig 4 - Gampola- Nuwaraeliya road at Dolosbage**

## **3.0 Land, Land use and Development Planning Considerations**

### **3.1 Land and Land use**

Land is an essential nature resource both for the survival & prosperity of human being and it also maintains all terrestrial eco systems. Land degradation result due to many causes in natural, physical & anthropoleal activities. It impacts on other factors such as flora and fauna, surface water distribution and climate. Due to increased use of lands in hilly area, the ecological balance has changed considerably recently. From the agricultural perspective effects of land degradation could be directly linked to the natural fertility level or crop production. The following table reveals that misuse of land threat the reservoir in the country. That implicate of degradation on economy, society, physically and environmentally sustainability.

**Table 3.1 Percentage Area under Erosive Land use in the Reservoir Catchments**

<b>Reservoir</b>	<b>% under Erosive Land use</b>
Kotmale	15
Polgolla	-
Victoria	21
Randenigala	31
Rantambe	29
Castlereigh	21
Norton	24
Maussakele	09
Canyon	12
Laxapana	22
Samanalawewa	23

Source: Landuse Policy Planning Deparment

### **3.2 Land Management**

The main purpose of planning is formulating a new image about the future land use needs and then to set out the optimal solutions for convert and foreseen problem and issues. Therefore it is important to develop suitable planning measures to carryout development activities. Development activities mainly deal with the land, but due to the different physical and topographical settings the nature and character of the land differ from one area to another.

Availability of flat lands with easy accessible terrain is limited in Sri Lanka due to existence of hills and ocean right round the country. Therefore development activities are getting concentrated in the hill slopes with the widening infrastructure facilities. As a result hill slopes are exposed to number of environmental and physical issues which lead to landslide, collapsing rocks, ground failures, siltation, soil erosions the it gradually destroy the inherited visual quality are some of the results of the invasion activities.

Planning and technical guidelines and regulation applied in the development of the hill slopes become a major problem to the local authorities and decision makers such as Developers and town planners when deciding the proper development activities in the sloppy areas. Therefore it is necessary to study the impacts of the unplanned development activities and to identify the major causative factors of such development activities.

## 4.0 Gaps Between Landslide Mitigation and Planning Regulation

### 4.1 Application and Gaps in Existing Laws and Regulations Development Activities in Hilly Areas

- Improper land sub division for developed in hilly areas without giving adequate attention to the contours can lead to landslides and cutting failures. In fact it caused to increase the risk. planning application in local authorities do not match with their local authorities concerns
- Most of the local authorities in the landslide prone areas do not have building approval procedure. They practice even without a building approval committee and also non regulation building increase the risk level to both occupants and surrounding areas. Ex: they building of their houses in marginal lands without getting through building and planning procedures.
- Unplanned housing schemes, resettlement programs construction and land development activities without proper planning and technical guidelines lead to increase the risk level. (fig 5)



Fig 5 - Danilo Resettlement site in Walapane

- The limited integration between the relevant authorities when deciding the development activities in the sloping regions.
- The absences of proper and scientific planning and building and technical guidelines to guide the upcoming development activities as well as existing development and land use.
- The limitation in the necessary professional inputs in the local authorities such as town planners, geologists, structural engineers for deciding the proper land use and development activities in the sloping lands.
- Although the comprehensive development plans for urban areas are prepared by the Urban Development, development activities have happened in the sloping areas in the past without proper guidance of a regulatory authority, requiring more attention in these areas issues. (The comprehensive development plan for Kandy city was gazetted in the year 2002, yet more than 97% of the residential units before 2001).
- The limitation in the gazette regulation in the national level to control the unplanned development activities in the sloping areas.

### 4.2 The Limitation in applying of Technical Guideline in the Sloping Region

When deciding development activities within the sloping areas planning regulation on minimum plot size are used mainly to control the subdivision. But there is no special regulation and technical guidelines for development activities in the slope categories. In many urban areas the minimum land

sub division is 6 perch; the plot size apply to housing construction. The 6 perch plot size was considered as sufficient in the city of Colombo and suburbs as the available infrastructure is adequate to 6 perch plot size. But in the hilly region this plot size is not suitable for housing construction. This can be considered as one of the main reason causing of landslide in the hilly areas. Fig 6 shows the poor use of general minimum plot size in fragile hilly slopes.



**Fig 6 - Seetaeliya Nuwara Eliya**



## **5.0 Land Use Planning as a Tool to Control Development in Landslide Prone Areas**

### **5.1 Stakeholders Implementing Planning and Building Regulations Involved in a Land use Planning**

Local authorities utilize land use regulations to prevent or regulate development within landslide prone areas. The main reason is that land use planning allows certain development on landslide prone areas to landslide depending on the vulnerability.

Local authority is the implementation authority to issue building and other development permits within their administrative boundary. However, local government administration and elected members of local government usually have conflicts in interest conflicting interests in land management and development. Issues Professional and technical staff of local governments are subjected to pressure from political leaders to issue building permits.

### **5.2 Planning Legislations**

Large numbers of legislation have been in place to deal with lands, land management and development planning in the country. They have been enacted from time to time depending on the national development policies. Absence of a good land use plan and poor implementation in a major issue in hilly areas as it affected non regulation of environmentally sensitive lands, unauthorized construction, encroachment on to undevelopable lands, ignorance of significance of planning and building regulations and also poor adaptation of such regulation. Land use planning mentioned that guideline do not apply to private lands. It is needed to adhere to proper guidelines for settlement in both state and private lands. These individual actions lead to collective disasters.

## 6.0 Recommendations

### 6.1 Land Use Zoning Regulation

Land use planning is very important tool for mitigation of landslide prone areas. It can be implemented by enforcement through statutory acts, local authorities and currently the provincial council system with 13<sup>th</sup> amendment. Using of land use planning as a tool in disaster risk reduction is still not so widely recognized. The advantage of using this tool is not recognized by policy makers and implementers in Sri Lanka

Land use zoning regulation provides direct advantage by restricting development for most hazardous in high risk zones and confine other development activities to conditions depending on the degree of risk in the area. Presently most of the local authorities do not have land use zoning plan or by law spatially deny for disaster risk reduction. Therefore it is necessary to each local authority having declared risk areas should to develop and use a land use zoning plan for the given local authority areas. This can be done with the assistance and advice of the Urban Development Authority, National Physical Planning Department and different land use planning offer.

### 6.2 Sub Division Regulations

Regulating the design on sub divisions (planned local units of lands designed with streets, side walking, sewerage etc. in preparation for building dwelling houses) is another way of controlling development. The land subdivision regulation process to be incorporated into the planning approval process and the subdivision design and joining regulations must be based on geotechnical and geological information. The average land extent to be decided accordingly.



Fig 7 - Hantane Housing scheme

### 6.3 Slope Density Regulation

Landslide hazard is directly connected with the steepness. Therefore it is very important to regulate slope density which establishes maximum density for various slopes.

Slope density regulation is very important to decide minimum plot size or density that emphasizes percent open space rather than parcel size and it is more tightly linked to landslide hazard mitigation. It encourages the clustering of dwelling units.(Fig 7 )

## **6.4 Building Regulations**

Land use regulations have direct connection to building regulations. Building regulations are applied in urban areas as a disaster risk reduction activity. Such practices can be established for different zones depending on the degree of risk. Ex. Low risk area can be allocated for high density human settlements with access roads. But in medium risk zone residential building clusters constructed using engineering designs can be allocated with common parking lots rather than individual access. This will ease the load in providing individual access to each plots. Building application should be modified for each local authority after considering information related to risk reduction and will include relevant agencies in the approving mechanism.

## **6.5 Special Regulations**

Special regulation can apply for complex structures like sewerage disposal systems that rely on absorption (ex. Septic tanks, leaching fields, seepage, pits) that can saturate the surrounding soil and even rock and cause failures. Therefore such design must be based on geotechnical information. Most importantly to provide central network of tank to minimize problematic sub drainage, drains similar to stepped drains of with steep slopes to facilitate rapid surface run off of rain water, sewerage line for residents rather than having individual septic tanks in hill slopes. Ex: Hantana Housing Scheme (Fig 7)

## **6.6 Strengthen Landslide Study Institutions**

Institutions such as NBRO need to strengthen in conducting landslide studies, research and services to serve as national focal point Local Authorities should be the implementing agencies when issuing of building permits and other development activities. However it is necessary to get the consent of specialist agencies like NBRO. Land use map or zone to be should be based on landslide hazard zonation map or other hazard zonation maps.

## **6.7 Responsibility of Local Authorities**

Government and local authorities have to play a leading role at various levels. They should develop plans to mitigate natural and manmade disasters. Organizations should have their own way of preservation of environment to cooperate with other government and responsible institutes like Disaster Management Center, Mahaweli Authority, Department of Agriculture, UDA, social services, housing, health etc. whom have their own disaster mitigation planning units.

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