

Essential Human Settlement Planning Considerations for Sustainable Landslide Mitigation: With Special Reference to Padiyapelella Landslide Area

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ABSTRACT: In the last two decades Sri Lanka faced adverse impacts of several natural disasters. Among them, landslides occurring in the central hill country were the ones with the most hazards. Landslides that occurred prior to the dawn of the 18th century were considered as isolated events, and were attributed due to its natural causative factors and had a low hazard level. Rapid development in the hilly terrains which took place proceeding this era has resulted in an expansion of human settlements thus increasing the risk to lives and properties. Changes in land uses had introduced “human induced” landslides which is estimated at 80% of total landslide events.

During 1990s the state had embarked on Landslide Hazard Mapping Project (LHMP) implemented by the National Building Research Organisation (NBRO) with the view to identify landslide prone areas of the country. The method used to assess the potential for landslide hazard is expressed qualitatively as low, medium and high. Recent landslides that had occurred within already mapped regions show that they fall within areas with medium to high hazard levels. The reliability of hazard maps has encouraged the decision makers to adopt these for planning purposes. Since 2009, the state has taken the initiatives to implement landslide mitigation projects in identified high hazard areas. Structural landslide mitigation measures have been implemented in selected high risk areas in recently landslide impacted area of Padiyapelella and Peradeniya.

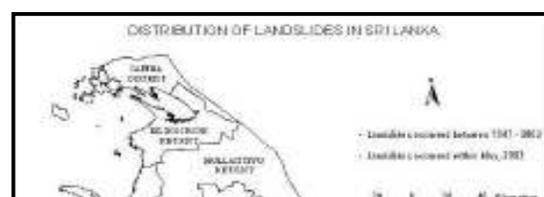
The general objective of a mitigation strategy is to reduce the risk of death and injury in hazard prone areas. At the same time such measures should be financially viable in long-term, benefitting present and future generations as well. The socio-economic study carried out in Padiyapelella landslide area, reveals certain mediatory aspects that are essential for human settlement planning needs to ensure long term sustainability. This paper discusses some strategies that can be added with landslide mitigation work.

Keywords: Landslide, Sustainable Landslide mitigation, Human settlement planning considerations

1 INTRODUCTION / BACKGROUND

Landslides are essentially due to a natural phenomenon, where nature reforms its landforms. This process is accelerated by seasonal high intensity rain fall. The characteristics of slopes and rainfall intensity are two of the five factors that contribute to potential instabilities. The studies carried out by National Building Research Organisation (NBRO) reveals that, 10 out of the 25 districts in Sri Lanka are prone to landslide hazard. These ten districts cover nearly 30% of the total land area of the country, and spatial landslide occurrence is estimated at 1-2 events per square kilometer.

During the last three decades damages to life, property and human displacements resulting from landslides are reported at an increasing frequency, due to increased number of human settlements in such fragile lands. Figure 1 shows the distribution of landslides in Sri Lanka and Table 1 shows the population distribution and number of landslide events in year 2006 in landslide prone districts.



During inter census period of 1981 – 2001 indicate previously slow growing hilly towns Haputale, Bandarawela, NuwaraEliya, Hatton – Dikoya and Badulla have experienced relatively high growth rates. Most of these settlements are small and medium towns in districts like NuwaraEliya, Kandy and Badulla. The reason for such high growth rates in these towns and periphery are due to increasing in traditional and non – traditional export crops, growth of industries, trade and tourism. (Survey Department of Sri Lanka, *The National Atlas of Sri Lanka*, 2007, Second edition).



Fig 02 Settlements at hilly areas of NuwaraEliya town

Fig 01 Landslide Locations in Sri Lanka
(Source: Landslide Studies and Services Division, NBRO)

These findings raise an important issue: as to why such human settlements continue to occupy these fragile areas even after witnessed the damage caused to lives and properties? One main reason had been the introduction of plantation economy during 18th century, which had opened up opportunities, hence new livelihoods in the area. It is also noted that majority of middle income families occupy flat lands that are limited in extent. This has compelled low income families to settle in the hazard prone areas mainly with poor access, poor drainage facilities and poor ground conditions.

Table 01 Population distribution and number of landslides in year 2006 in landslide prone districts.

District	Population Density (Per sq.km) in 1981	Population Density (Per sq.km) in 2001	Number of landslides in 2006
Kalutara	519	673	-
Kandy	541	664	07
Nuwra Eliya	347	410	-
Matale	179	227	03
Ratnapura	243	312	03
Matara	510	599	03
Badulla	224	274	09
Keglle	405	463	11

(Source: Department of Census & Statistics and NBRO)

2SUSTAINABLE DISASTER MITIGATION

Disaster mitigation generally refers to all actions that reduce impacts of disasters prior to occurrence. This includes preparedness and long-term risk reduction measures, both planning and implementation of such measures used to reduce the risks associated with known natural and human-made hazards and the process of planning for effective response to disasters. (A.W. Coburn, R.J.S. Spence, A. Pomonis, *Disaster Mitigation Training Module*, 1994).

A core assumption of disaster mitigation is that the amount invested today should reduce the demand for future investments for emergency recovery, repair and reconstruction following a hazard event.

Studies carried out by experts in several countries reveal that, disaster mitigation based on physical or structural interventions alone are inadequate. The concept of sustainable disaster mitigation was introduced to overcome these shortcomings and has been used over the past fifty years. It begins with the pioneering work of eminent geographer F. Gilbert White (1945), who first studied the control of land use in floodplains as a means of reducing flood loss rather than the relying on structural flood mitigation

(AimeTsindaand Alexis Gakuba, *Sustainable Hazards Mitigation in Kigali City*, 2010). Sustainable disaster mitigation entails long-term planning and implementation multiple objectives. It aims to improve living conditions of the poor and to safeguard the environment, while meeting the needs of current and future generations. This framework includes six basic components for sustainable disaster mitigation namely, environmental quality, quality of life, disaster resiliency, economic vitality, inter – and intra – generational equity and participatory process (D.S Mileti, 1999).

3 LANDSLIDE MITIGATION STRATEGIES

Main objective of landslide mitigation is to reduce losses due to a triggered landslide or a potential landslide. Mitigation strategies mainly focus on reduction of risk of death and injury to the population and include reducing damage and economic losses inflicted on infrastructure facilities. Landslide mitigation strategies can be relocation of settlements including infrastructure, location planning to avoid hazardous areas, introduction of engineering structures to reduce the vulnerability and increasing capacities through non structural mitigation etc. is used. Also landslide mitigation strategy should lead to create an atmosphere that allows the local community and its users, using the settlements without any fear.

In Sri Lanka location specific livelihood and socio-economic conditions prevailing in such settlements prevail them from opting to relocation strategy. Considering this reality, as a pre-landslide risk reduction strategy, several mitigation measures short-term and long-term have been implemented as structural and non-structural measures. Structural mitigation measures included drainage system development, construction of retaining walls, anchoring of unstable overburden, tree planting, soil erosion controls. And non-structural mitigation measures includes early warning systems, land use zoning, awareness programmes, implementation of guidelines and regulations for construction in steep slopes etc. Road map to Disaster Risk Management in Sri Lanka prepared under the Disaster Management Act No.53 of 2005 has identified Landslide Studies and Services Division (LSSD) of NBRO to undertake mitigation, preparedness, early warning, recovery and rehabilitation of landslide prone areas.

Recently, NBRO was assigned the task to implement two mitigation works at identified high

hazard areas for the benefit of two settlements. The first is to carry out mitigation work on Peradeniya landslide which affected the local settlement and a major highway. The second is Padiyapelella landslide mitigation which has affected the settlement in Padiyapelella. Padiyapelella mitigation experience has been selected for discussion in this paper since it includes a typical settlement than Peradeniya landslide mitigation.

4 PADIYAPELELLA LANDSLIDE AREA

The landslide hazard zonation map prepared in 1994 by the NBRO identifies a high intensity of landslides in the areas of Hanguranketha and Walapane in Nuwara Eliya District. In year 2007 a number of landslides occurred within a small geographical region of Hanguranketha and Walapane, during the rainy season, with severe trauma to local communities. Padiyapelella town which is located in Walapane D.S Division was also affected. These areas are still vulnerable to such future events.

4.1 Background of structural landslide mitigation

Padiyapelella town has been subjected to landslides and rockfalls since 1980s, during north-east and south-west monsoon periods. As per the project team the main reason behind the implementation of structural landslide mitigation in Padiyapelella town is its locational advantage as a linear commercial town along main transport route and commuter movements towards this town due to its transportation linkages with Walapane, Rikillagaskada, and Hanguranketha towns. Thus, this town differs from other landslide black spots in Walapane D.S Division. Figure 03 shows the transportation linkages with other towns.

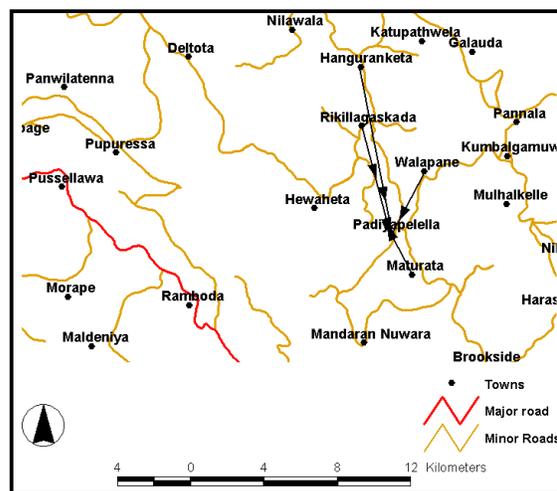


Fig 03 Transportation linkages of Padiyapelella town

4.2 Location

Padiyapelella town is a linear town located along the Mathurata - Ragala Road between Rikillagaskada and Walapane towns in NuwaraEliya district. Topographically this town centre is located approximately between 600 m to 700 m above mean sea level.

4.3 Land use

Land use pattern of the Padiyapelella town area consist of residential, commercial, water body and paddy cultivation. The town area has been surrounded by grass land. Figure 04 shows the location of commercial activities at the town centre.



Fig 04 Commercial activities at the town centre

4.4 Urbanization pattern

Transportation linkages with Walapane, Rikillagaskada, and Hanguranketha towns attract commuters towards Padiyapelella town and agglomerates economic activities. But the trend pattern of residential activity gathering has reduced during the last 15 years. Figure 05 shows the percentage of buildings in different age groups located at the town centre.

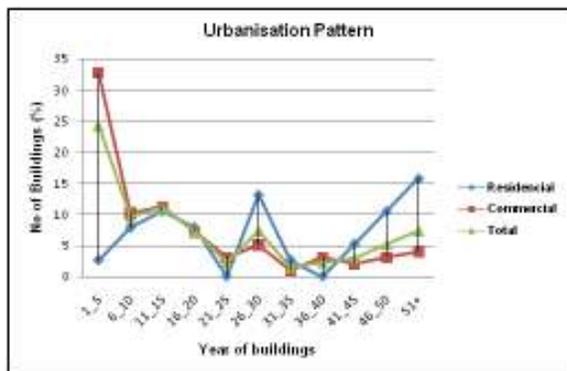


Fig 05 Urbanization pattern in Padiyapelella town

4.5 Population

Total population residing in Padiyapelella G.N Division is 697 persons and the population density of the G.N Division is 18 persons per sq.km. At the same time population density in Walapane D.S Division area is 332 persons per sq.km. The socio – economic survey indicated that the total population residing within the project area is 205 in an area of 8500 sq.m. Out of this population, comparatively a few numbers of persons are temporary resident in this town closer to their working places. Most of the commercial building owners are not resident and they daily travel from other areas for their business activities. Population pyramid indicates the younger population is comparatively higher than the elderly population.

4.6 Threaten by landslides

Socio – economic survey indicate that 55% of housing units face the high risk and 45% face the moderate risk. Also the study revealed that out of the total number engaged in business activities 52% of people like to be relocated and 34% of people did not like to be relocated due to the need to redevelop their economic activities in case of relocation.

5 DISCUSSION & CONCLUSIONS

Ancient settlements in Sri Lanka were located away from natural disasters considering topography, climate and economic base. Due to the changes in economy the settlements diverted into fragile areas and created settlements vulnerable to natural disasters. Especially, the introduction of plantation economy let the settlements accommodate into central fragile areas. The reasons for occupying fragile areas are influenced by dependency on location specific livelihood, lack of alternative opportunities, scarcity of land, and to gain access to employment opportunities. The above reasons have led to the utilization of land resulting in inappropriate land use practices such as unplanned settlements without access, blocked natural draining paths, cutting and filling of slope, clearing of forest etc. This situation not only endangers future sustainable living, but also puts the existing built environment at extreme risk. For more than two decades these settlements have experienced the catastrophe of landslides. Loss of lives, damages to properties, damages to infrastructure, damages to livelihood and environmental degradation are the major adverse impacts. Considering these facts for the

first time in Sri Lanka landslide mitigation measures have been implemented in identified high hazard areas.

With the above circumstances, to ensure long term sustainability of landslide mitigation, following essential human settlement planning aspects need to be included with landslide mitigation work.

- i. At first landslide mitigation must address the ongoing socio – economic process, which marginalize the people and increase vulnerability.
- ii. Environmental quality improvement and disaster resiliency is essential which includes restricting development through land-use planning in these fragile areas.
- iii. Community responsibility and resiliency must be developed. Certain degree of self sufficiency is required by the community to endure with minimum loss and damage. This requires a conscious effort by the settlements to be aware of environmental problems, and environmental sustainability issues specific in their areas.
- iv. Strengthen the settlement condition by improving the housing condition, provide knowledge on construction methods, housing design, building materials etc.
- v. Promote cooperation between national, regional and local level authorities in order to complement each other. These institutions possess powers, experience and resources to cater to all aspects of decision making.

6 RECOMMENDATIONS

Based on the above conclusions, following essential human settlement planning components are recommended. The recommendations specifically refer to landslide mitigation work in Padiapalella, they may serve as general guidelines for sustainable landslide mitigation.

- i. Prior to the implementation of structural mitigation measures a human settlement study is an essential aspect to assess both tangible and intangible benefits that makes the investment financially viable. Such a study may assist in the analysis of comparative advantages of the identified location /town than other landslide black spots in and around the area.

- ii. Transportation linkages with other town centres attract commuter movement and agglomerates economic activities in Padiyapelella area. This situation rise the risk of the commuters and settlements in the area and also leads to human induced landslides. Regulating land-use, and enforcing land-use and building regulations need to be done via its local authority.
- iii. In order to preserve and maintain the environmental quality the development activity must be assessed prior to implementation by the relevant authorities. Special emphasis to be made by local government authority to preserve and maintain environmental requirements that reduce landslide susceptibility.
- iv. Awareness programme to be conducted on appropriate land use practices, construction guidelines, preventive measures and mitigation measures for landslides.
- v. Local, regional, national coordination must be established, which can be established through formulation of Community Based Organisation (CBO) which may serve as the coordinating body on behalf of the community of the area.

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