A Study on Environmental Issues due to the Development of NuwaraEliya Badulla Road

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Abstract

Special emphasis has been given on road construction by the National Highways Sector Project (NHSP) of Sri Lanka in order to bring socio-economic upliftment. However, construction and developments of roads of the country create many environment issues. Rehabilitation and improvement of the NuwaraEliya - Badulla road which run through the hilly area were established in 2010. Construction length of the road was considered to identify the environmental impacts. Slope instability, hydrological conditions, soil erosion and blasting effects were studied. Disturbance of the natural drainage systems and making deep cuts and fills across already fragile slopes were identified as the main causes. Highly unstable slopes are identified in the Dabalawelahinna area. Dougolla Oya and Gregory Lake are the hilly affected water bodies of the area. Area around the rock quarry has been affected due to blasting vibration and high air blast over pressure. Since the vibration of back side of the quarry is high, landslides can be occurred in future. The life style of species live in Hakgala strict nature reserve has been disturbed due to noise and vibration. Prior to the construction of roads in hilly areas, special attention should be paid, specially on the morphological and geological conditions.

Keywords: Blasting effects, Hydrology, Remedial measures, Slope instability, Soil erosion

1. Introduction

The hilly tribal area's road construction creates a large number of ecological and environmental problems [1]. The use of land to provide the road formation width, the construction of side drains, retaining walls and breast walls, the degradation of cultivated land due to side casting and the effects of spoil spillage on downside land areas are all factors directly affecting the livelihoods of the people who live on an agricultural subsistence [2]. Excavation on geologically vulnerable slopes can trigger erosion, mass wasting and sedimentation. Disturbance of the natural drainage systems and making deep cuts and fills across already fragile slopes are the main causes.

According to hilly road construction, the environment impact differs than road constructions in other areas. The NuwaraEliya Badulla road development project in hilly and heavy rainfall area will have a high impact on the environment during the construction stage and also after construction.

This study was conducted with the main intention of looking at the environmental impacts of road construction in hilly ethnic areas, with considering 8 km length from road length. Furthermore, this study raised the necessity of mapping the scale of impact to identify the environment impacts.

1.1 Study Area

The study area lies between the Bandarawela Junction at Welimada and Dabalawelahinna. Barring a few small towns, the road passes mostly through a hilly mountainous terrain, under range of annual rainfall 1000-2000 mm in land slide prone zone along forested rural area. The basement of the area is covered by precambrian of granulite grade proterozoic metamorphic rocks sequences belonging to the Highland Complex. The complex consists of charnockitic gneiss, charnockitic biotite gneiss, garnet silimanite biotite gneiss, marble (crystalline limestone) and quartzite. All these rocks have been deformed under granulite facies conditions into open, tight, up-right and overturned antiforms and synforms [3].

The central hilly area of Sri Lanka is categorized as upland and highland areas [4]. The uplands, with elevation from 270 m to 1060 m, are characterized by ridge and valley topography and their average slope varies from 10° to 30°, depending on lithology and structure. Highlands, with elevations ranging from 900 m to 2420m appear as a series of plateaus rimmed by mountain peaks and strike ridges.

1.2 Objectives of the Study

The objective of the present study is to identify the environment problems created by the road construction from NuwaraEliya to Badulla. Also it focuses on suggesting some prevention measures to minimize the identified problems.

2. Method of Study

Field investigations, collection of data in the field, data analysis and preparation of different maps are the major steps of the study.

2.1 Risk Assessment Methods for Slope Stability

The risk of the area is determined considering the following relationship.

Risk = Probability (hazard) x Consequences ....(2.1)

Hazard Number = Hazard Score x Probability Score ....(2.2)

Adverse Consequences = Risk Value x Vulnerability ....(2.3)

The risk, expressed as a risk number (R_N), is calculated as follows;

Risk Number = Hazard x Probability x Risk value x Vulnerability ....(2.4)

The risk number was calculated as defined by [5]. The risk numbers produced can then be used to place each site within an arbitrarily defined scale of risk classes that allow some comparison between sites and, thereby, provide a basis for hazard identification and management decisions.

R_N > 100	V	Very high
R_N 61- 100	IV	High
R_N 31- 60	III	Moderate
R_N 16- 30	II	Less moderate
R_N 0- 15	I	Low

Instability conditions of the slope (R_N) are evaluated under risk level and implications. Risk levels of slope and geological settings were considered for preparing slope instability risk map. Last ground vibration and air blast over pressure were measured during the study period to prepare the risk allocation map in the quarry area. Intensity of erosion and deposition of sediments were considered for preparing soil erosion map. Alteration of drainage network is considered for preparing drainage alteration map.

3. Results and discussion

3.1 Land Use Pattern and Land Instability

Land use pattern is highly variable on both sides of the Road of the Way (ROW) that illustrated the agricultural lands and homelands cover 59 %, and 22.6% respectively. Natural vegetation area is only14.4%. Area of rock exposure is about 5%.

Exposed area of rock slopes after the slope cutting, is 50.3% and soil slopes cover around 46.9%. Flat lands are 2.8%. About 8.9% of the total length has been covered by risk level 5. Risk level 4, 3, 2 and 1 are 20.9%, 36.1%, 30.3% and 3.6% respectively. Highest risk level represents in landslide prone areas.

3.2 Cut and Fill Slope Failure and Rock Fall

According field survey, the slope angle in the range of 46 to 65 is the most common. Soil slopes with 30m height or less than 30m are the most common slopes in the area. Hydrological conditions, construction conditions including the excavation scheme, excavation method and explosive method are more effective on soil slope instability than the angle and height.

Present study revealed that there is a high possibility for slope failures along ROW after the constructions. New unstable areas have been identified in slope instability map. Due to heavy blasting practices, high dumping and week slope characteristics, some structures are under threat in terms of landslides or hazardous floods. Locations of slope failures near to road rock blasting activities within 100m zone have occurred at Pallegama, Dikkapitiya and Mirahalgama.

However, the mitigation of slope failures often needs to be prescribed on a case by case basis because every slope is unique. The best solution for areas where hazardous slope failures occur is not to place any structures on or near the slope. The effects of landslides on people and structures can be reduced by the total avoidance of landslide hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity.

3.3 Hydrological Problems

Due to rehabilitation and newly construction of water ways is introduced the high run off for the down slope with introducing erosion and siltation by altering natural water paths. Natural drainage alteration leading to increased erosion and reduction of arable lands. Sustainability of the natural hydrological network is very important for supporting the natural environment, erosion control and sustainable development.

There is numerous water resources including ponds located along the ROW. Most of them are used by the local community for washing, bathing and other domestic purposes. Most of these surface water bodies have altered and been contaminated due to the various construction activities. Some of these water bodies such as Gregory Lake are historically and culturally important.

When considering the length of the ROW, the Uma Oya and tributaries have always kept getting worse due to the dumping of materials, entering to polluted water from construction area , fly rocks from blasting areas, muddy, dusty, siltation etc. These debris and silts can travel a distance via the stream and can be deposited in placed ponds, stream bends, lakes, etc…

Also, debris of landslide can increase the sediment load of streams or can cause channel blockages. Hence the stream diverts can creates flood conditions or localized erosion. Landslides can also cause overtopping of reservoirs and reduce the capacity of reservoirs. Also water pollution with sedimentation can be occurred in down streams. Hence, downstream aquatic life is under threat.

Though, drainage alteration and downstream erosion or siltation are anticipated during the construction period due to the improved design and added capacity of the cross-drainage structures, there should be an improvement in the drainage characteristics of the surrounding area.

3.4 Soil Erosion and Mitigation

The erosion of the areas has intensified due to high runoff, soil disposal confidence, over burden removal, alteration of the geological conditions and soil exposure. Also, the road is constructed in hilly mountainous terrain, under an annual rain fall range of 1000 - 2000 mm in land slide prone zone. These features will help to accelerate the erosion rate on bare soil surface of cut and fill slopes and surfaces.

Soil erosion and rock failures have taken place in Hakgala area during road construction and natural ecosystems has heavily been damaged. Due to relatively high seepage of the Hakgala area and unstable soil type (red yellow soil (leached lateritic soils)); the slope failures can occur at high rates compared to other areas. Hence gabion wall have to be placed in such areas to establish the cut wall and to reduce soil erosion. This may avoid siltation of streams in the area.

Stability of soil is very important for erosion control, air quality and agricultural activities especially in an area with widespread erosion processes [6].

Though this is a genuine concern, the benefits of realignment in terms of increased flows, safety and improvement in ambient air quality in settlements avoided will compensate at least in part for the loss to the economy as a whole.

3.5 Rock Blasting Effects

Rock explosive blasting has been occurred in road way and quarry. Blasts in road way were on a minor scale. Structures as well as flora and fauna can be destroyed by fly rocks, ground vibration and air blast over pressure.

Most vibrated and noise high area is the quarry site of the construction road way. According to that, different risk zones can be identified in quarry site. To remediate this, land stability continuously around the quarry has to be monitored and it is needed to pay compensation to the structures around by considering crack analysis.

In addition, Marble rocks were found in the Rendapola area. During blasting, these marble can increase lime content of the soil and excess of them is harmful to plant growth. Also, fracture intensity of marble can be increased and the weathering of marble can increase.

4. Conclusions

Environmental problems have been increased in the study area due to the development of the road. Common environmental impacts identified are (i) slope instability, (ii) siltation of natural water bodies and streams (iii) soil erosion, (iv) dust accumulation due to blasting and (v) distortion of natural habitats.

Highly unstable slopes are identified in the Dabalawelahinna area and it is due to the improper cut angle of slopes, unstable soil types and occurrences of seepage.

Dougolla Oya and Gregory Lake are the highly affected water bodies due to the siltation. Area around quarry has been affected due to blasting vibration and high air blast over pressure. In this area, more than 120 dB air blasts over pressure values were detected. Since the vibration of back side of the quarry is high, landslides can be occurred in the future. Hakgala strict nature reserve has been highly affected from construction. The life style of species live in the natural reserve has been disturbed due to noise and vibration. However, such problems will not be appearing after the construction.

Future road constructions in the hilly country are supposed to be planned properly by considering the morphological, geological and social setting of the proposed areas.

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