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RESEARCH ARTICLE

TEMPORAL CHANGES IN BHYARI LANDSLIDE AND ITS EFFECTS ON ENVIRONMENT (GARHWAL HIMALAYA)

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ABSTRACT

Landslide is the nature of a complex process that has been modifying the mountain landscape in the Himalaya. Generally it serves negative effects on local environment. Present study pertains to hazardous zone of the Pinder valley between Narayan Baggad to Tharali in Garhwal Himalaya. The temporal investigation of Bhyari landslide covers the period 1958 to 2014. It is estimated that the Bhyari land slide is accelerating at the rate of 0.25% per year. About 2.03% area of the landslide has increased in between 2012 and 2014. The cultivated land is submerging in the landslide zone at the rate of 0.25% per year. If this trend continues, then entire Bhyari village will be engulfed into landslide zone with in 86 years at the rate of 0.25% (0.1 hac) per year. It is a very serious threat to the inhabitants of Bhyari village and their properties and demands some urgent slide stabilization measures.

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INTRODUCTION

Himalayan region is facing multi-dimensional problems of environmental degradation. Landslide and related mass movement activities are common in the mountainous terrain. Landslide is one of the major environmental hazard in the Himalaya that pose serious threats to human lives and settlements, damaging property and disrupting vital infrastructure i.e., highways, pipelines, technoginic work, as well as agricultural field and forest cover every year during monsoon season. A number of authors have carried out their works on landslide and related mass movement activities in the region (Hewitt 1988, Bartarya and valdiya, 1989, Pachauri and pant, Gerrard 1994, Bartarya *et al*., 1996, Sati and Bisht, 1998, Paul *et al*., 2000, Gupta and Bisht, 2004; Ives and Messerli, 1981). An individual landslide involves varied processes at different part of the slope and cloud burst often with differing intensity during successive years (Chaudhary *et al*., 2010). The detail slope stability studies along Karanprayag-Gwaldam road is carried out by Kohli (2008) and Anbalagan *et al*., (2006) and Anbalagan & Parida (2013). Naithani *et al*. (2002) analyses the catastrophic landslide of 16July 2001 in Phata Byung area, Rudraprayag district. Restrence *et al*. (2009) focused landslide formation on humid environments because there the influence of biotic process is most visible. The present paper investigates the temporal changes and successive acceleration stages of Bhyari landslide and its effects on local environment in the Pinder valley of Garhwal Himalaya.

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Study Area

The Bhyari landslide is located middle basin of Pinder River in Chamoli district of Uttarakhand state, India (Fig 1). Geographically, study area is located between 79^0 5' 58" longitudes and 30^0 25' 50" latitude covering 39.82 hectares of land at the height of 1250m from msl. It is bounded by two small streams in both the side which joins in Pinder at its left. It is also known as Harmony landslide after by a road side rural service center which is 1km down from Bhyari (Kundbagad) but the entire landslide zone is in Bhyari revenue village. In this study it is called by the name of Bhyari landslide. Bhyari landslide is one of the biggest landslides of Garhwal Himalaya in Pinder valley traversed by Karanprayag-Gawaldam State Highway (37) which connects to Garhwal region with Kumaun region and serves as the lifeline of Karanprayag and related towns of Pinder and Alaknanda vallyes. It is also a strategically important high way. This road has been in news because of the devastating landslide at Bhyari (Harmony),

Narayanbagar and Kulsari during monsoon season (July to September) in every year. This landslide has become serious threat to the Bhyari, Chapeli and Viyung villagers and their assets. Therefore, detailed temporal investigation seems to be felt necessary for Bhyari unstable slope.

Location map

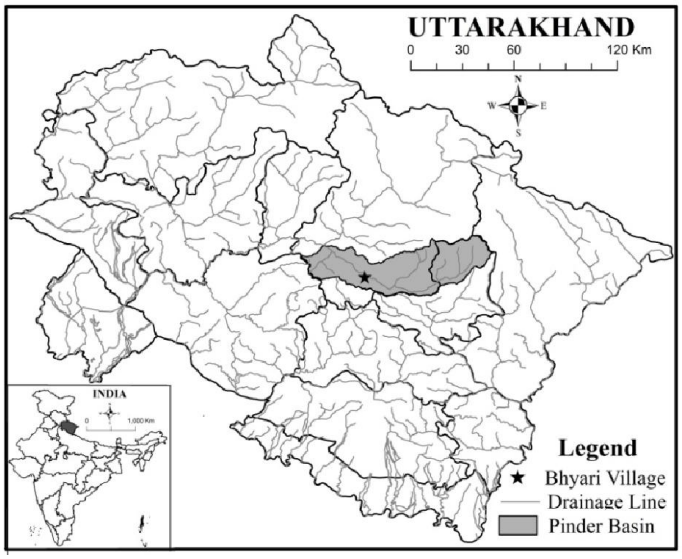

Fig. 1. Location of Bhyari Village

MATERIALS AND METHODS

The investigation of the Bhyari landslide was carried out on the large scale (1/1000) cadastral map of Bhyari village. Extensive GPS aided longitudinal and transverse in different phases were conducted along the road, foot path, over the landslide zone and agricultural fields in the study area. Effects and measures were under taken and information was collected during field visit. All the revenue maps of Bhyari village were digitized and thematic information layers were stored and managed in GIS spatial data base. Detailed morphological features of landslide exposures were marked on the map. The early revenue map has been compared with existing land records and change detection was quantitatively analyzed for landslide.

RESULTS

Various factors have been put forward for Bhyari landslide. Qualitative assessment indicates that there are number of factors responsible for the Bhyari landslide. Lithology, structure, slope, drainage, geo-hydrology, and rainfall are prominent in natural while land use and construction of road are common in anthropogenic. The morphometry of landslide is given in Table 1.

Temporal Changes in Landslide

Evaluation of the landslide hazard requires the reliable temporal probability of occurrences. Probability can only be predicted when the temporal rate of landslide is be determined. Data records of any landslide in the Himalaya are not available so that qualitative relationship could not be established between occurrences of event and active triggering events (Pellicani, Van Westen and Spillotro, 2014). Keeping in view the relationship between the existing landslide and its rate of acceleration and reactivation, cadastral maps (1958) of Bhyari village have been used for showing the temporal changes. On account of cultivated land which submerging in to slide zone is converting into waste land. Comparison of Plate 2a with Plate 2b shows that the landslide is moving towards the cultivated land. During field investigation, the past revenue map has been compared with existing position (2012 and 2014) and determined the changes on the map (Plate 1 & 2). The survey results are computed in Table 2 which shows the wide variability in the Bhyari landslide.

Sucessive stages of submerged area in the landslide zone

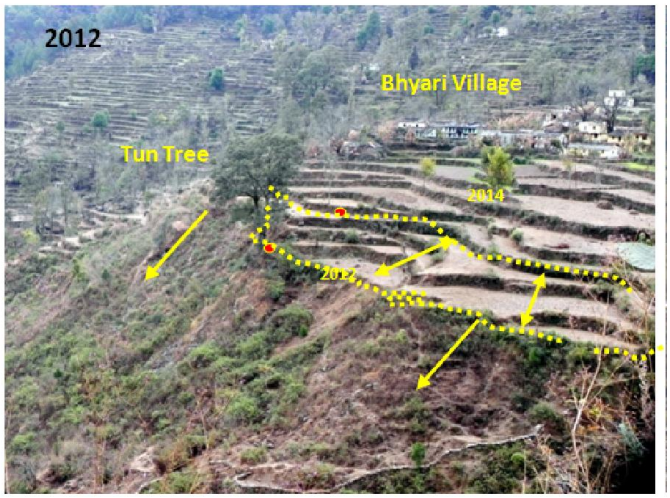

Plate 1

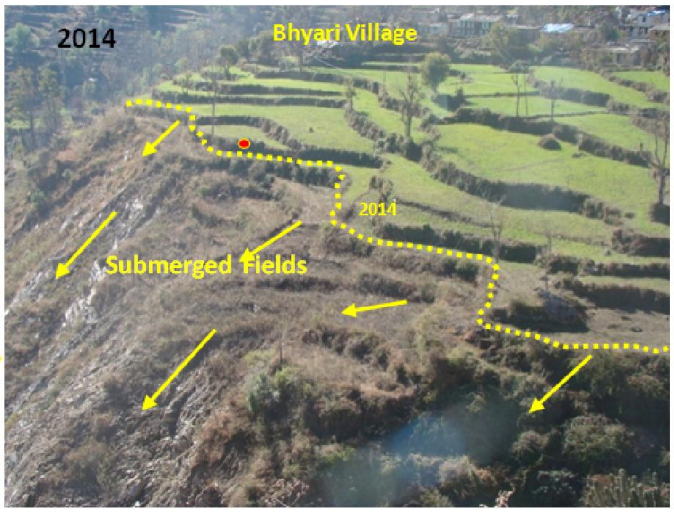

Plate 2

Table 2 reveals that cultivated land was 35.06% during the period of 1958 but reduced to 23.2 and 21.2 percent respectively during 2012 and 2014. During in 56 years, 13.87% (5.52 hec) cultivated land was decreased in the Bhyari village.

Table 1. Landslide Morphometry

Name	Type	Slope	Length*	Width*	Depth*	Area	Vol.
Bhyari Landslide	Complex	20-70^0	512m	494m	30-50m	14.66 hec.	10117147m^3

*Length, width and area are measured from rectified revenue map image.
*Depth is measured with the help of slope profile surface.

Table 2. Changing Trend of LULC (%) in Bhyari Village

LULC Class	1958	2012	Changes	Rate of Changes/y	1958	2014	Change	Rate of Changes/y	2012	2014	Changes	Rate of Changes/y
River	11.20	11.20	0.00	0	11.20	11.20	0.00	0	11.20	11.20	0.00	0.00
Landslide Area	52.20	64.22	12.02	0.222	52.20	66.23	14.04	0.25	64.22	66.23	2.02	1.01
Built up	0.12	0.12	0.00	0	0.12	0.12	0.00	0	0.12	0.12	0.00	0.00
Road	1.43	1.26	-0.17	0.003	1.43	1.26	-0.17	0.003	1.26	1.26	0.00	0.00
Cultivated Land	35.06	23.21	-11.85	0.219	35.06	21.19	-13.87	0.247	23.21	21.19	-2.02	1.01
Total	100	100	0.00	0.00	100	100	0.00	0	100	100		

Land use & land cover changes of bhyari village (1958 – 2014)

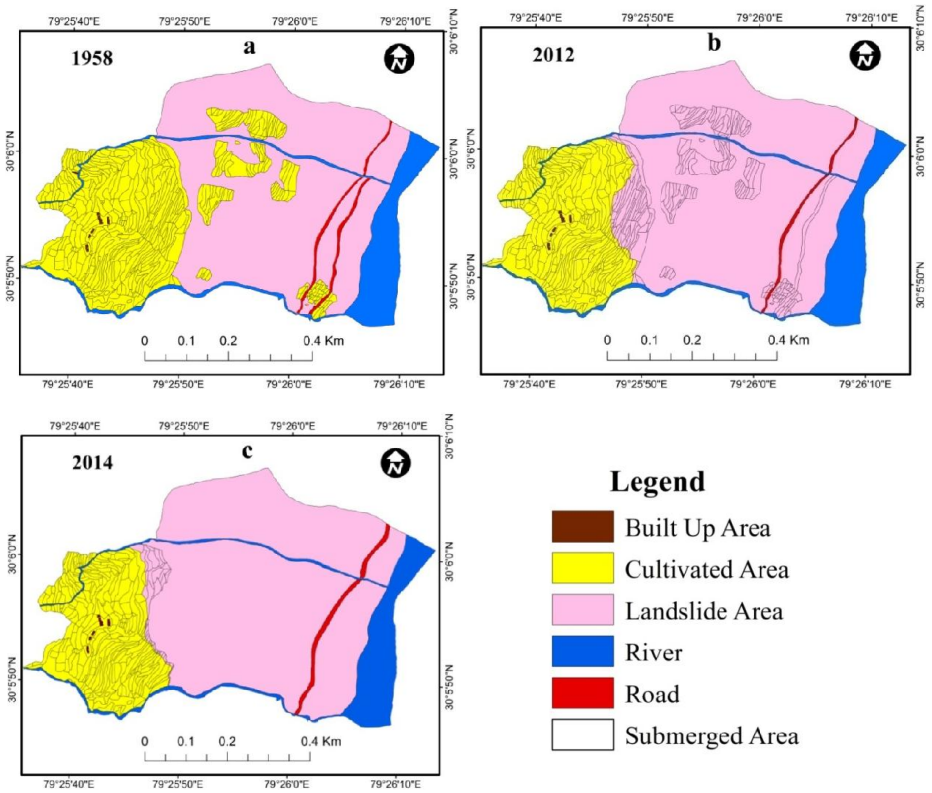

Fig. 2 a, b & c

Out of that 2.04% (0.8 hec) cultivated land was decreased in between 2012 and 2014. The most drastic changes are observed during Uttarakhand disaster in 2013. The decreasing trend of cultivated land shows that the area of cultivated land is submerging into slide zone at the rate of 0.25% (0.099 hec) per year (Fig.2). If this trend likely to continue than entire cultivated land of Bhyari village will be submerged into landslide zone with in 86 years at the rate of 0.25% per year. It is a very serious threat to the inhabitants of Bhyari village and their properties and demands some urgent slide stabilization measures. Table 2 (Fig. 2c) also reveals that the cultivated land was reduced about 2.02% during 2012 to 2014 which submerged into landslide zone. Beside this the area of landslide was 52.2% during the period of 1958 but it increased 64.22 % and 66.23% during 2012 and 2014 respectively at the rate of 0.25% per year (Table 2).

About 2.03% area of the landslide was increased in between 2012and 2014. The statistical matrix (Table 3) shows that the area of cultivated land is submerging into slide zone and converting into waste land (Plate 1 & 2).

Table 3. Matrix LULC data of Bhyari village (1958 to 2014)

	River	Landslide Area	Built up	Road	Cultivated Land
River	4.45	0.00	0.00	0.00	0.00
Landslide Area	0.00	20.61	0.00	0.17	0.00
Built up	0.00	0.00	0.05	0.00	0.00
Road	0.00	0.26	0.00	0.31	0.00
Cultivated Land	0.00	5.51	0.00	0.01	8.44

Very minor changes are found in the area of river, road and built up area (Table 2 & Fig 3). The area of the road alignment

is also changing every year because of slumping process. Every year 375m road is realigned on the landslide zone. Most of the changes are noticed after the monsoon season. Therefore, the wet season is one of the most triggering factors of landslide in the mountain region.

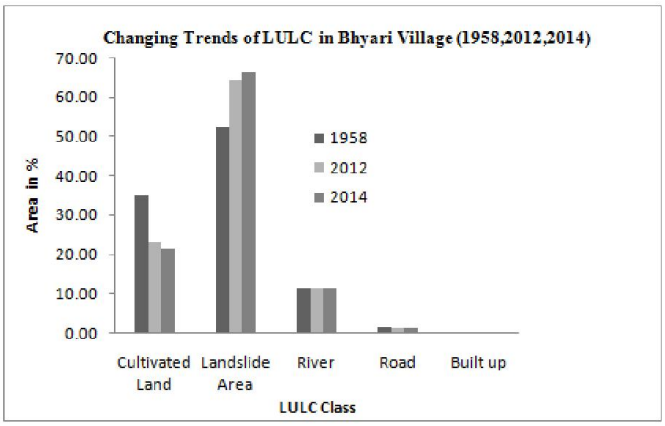

Fig. 3. Trends of Land use & Land Cover in Bhyari Village

DISCUSSION

Bhyari landslide is a very old landslide zone of Pinder valley but during last five decades it has reactivated time to time. It is evident that the slide zone of Bhyari village is changing in shape and size and continuously moving headword every year. After China war in 1962, the motor able road was constructed through this area in 1967. In the initial stage the effects of road construction was limited but in the latter stages it accelerated faster rate. Its sharp effects were observed after the earthquake of 1994. Fig. 2a shows that the cultivated terrace fields were existed within the slide zone in 1958 records. According to Syam Singh a citizen of Bhyari village interviewed that before or up to 1994 the owners were cultivate these fields regularly. But after the earthquake the drastic changes were recorded in the shape and size of Bhyari landslide. The cultivated fields were continuously submerged in the slide zone during monsoon season every year till this date. Fig.2b is showing that agricultural fields (without yellow color) have been slumped and submerged in the landslide zone up to 2012. The most natural triggering factor of this landslide is toe cutting by the Pinder River. Further activeness and intensity of landslide is accelerated by road maintenance at the toe zone of landslide. Every year hundreds of meters motor able road is slumped down (Plate 3) and alignment of road is constructed. Thousands of tons exposed material dumped down in the river from the excavated sites. Intensity and duration of rainfall are the most triggering factor of land use changes around the slide zone. During monsoon period some part of terrace fields at the fringe of cultivated land and slide zone is sliding down by the action of rain water and slope failure.

Table 3 shows that about 5.51 hector cultivated land of Bhyari village has been submerged into landslide zone since 1958. Its recent evidences can also be observed in the Plate 1 & 2. Here was a *Tun* (*Toona Ciliata*) tree at the boundary of cultivated site up to 2012 (Plate 1). But during 2014 field investigation, it was found that the tree was slumped down along with surrounding land into slide zone during 2013 disaster (Plate 2). The successive stages of acceleration and submergence can be observed on the map (Fig.2c) and plate 1 & 2.

Plate 3. Slumping of motorable road

Plate 4. Damaging houses due to slumping

Numerous affects of Bhyari landslide can be observed on local environment. Rock fall from scarps, sliding of fields, slumping and tilting of terrace fields (Plate 1 & 2), rotational tension cracks, toe cutting by river, new headword scars and lateral erosion by the streams, submergence of motor able road (Plate 3) and collapse of houses (Plate 4) are the prominent features about the recurrent activation of Bhyari landslide. Although such type of events are not happened every year but after a long time some mega events occurred in the mountain region of the Himalaya. It is noted that this 2013 mega event thoroughly created the instability all over the Bhyari village and surrounding environment. Field investigations show that whole slope of Bhyari landslide is unstable which creates instability effects. Bhyari village is located at the crown of the active slide zone. Due to the slumping and rotational slide numerous cracks were developed on the cultivated land and houses. Therefore, out of 27 households the 15 families of Bhyari village have been left the village and shifted to other places. Only 12 very poor households are living in the village that cannot effort to move other places. About 3 houses were tilted, 5 houses were affected by cracks on the walls and 3

residential and 2 cattle shed have been abundant in the Bhyari village (Plate 4). Similarly, out of 22 households, 7 households of Chapeli village have also been left the origin place and shifted others. Now another rehabilitation problem has arisen in the villages which are a matter of further investigation.

Conclusion

Temporal analysis of the Bhyari landslide concluded that its shape and size increasing every year at the rate of 0.25% /y. Due to tilting of land the residential houses and cattle sheds are damaging by tilting and cracks on the walls. The settlement are being abundant every year. Similarly the agricultural land of Bhyari village is submerging in to the slide zone at the rate of 0.25%/y. If this trend likely to continue than entire cultivated land of Bhyari village will be engulfed into landslide zone with in 86 years at the rate of 0.25% per year. Mitigation measures must be adopted for the control landslide so that the serious threat can be minimize to the Bhyari village.

Acknowledgement

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REFERENCES

Anbalagan *et al*. 2008. Stability Analysis of Harmony Landslide in Garhwal Himalaya, Uttarakhand state, India, Paper present in the conference of IACMAG Goa, India pp4652-4658.

Anbalagan, R. and Parida, S., 2013. Geoevironmental Problems due to Harmony landslide in Garhwal Himalaya, Uttarakhand, India**.** *International Journal of Emerging Technology and Advanced Engineering,* Volume 3, Special Issue 3: ICERTSD, pages 553-559.

Anbalagan, R, 1992, Landslide Hazard evaluation and zonation mapping in mountain terrain, *Engineering Geology*, 32, pp 269-277.

Bartarya, S.K and *et al.*, 1989. Landslide Hazards: Some Case Studies from the Sutluj Valley, H. P. Himalayan Geology, vol. 17 (1&2), Pp 193-207.

Bartarya, S.K, Valdiya, K.S., 1999. Landslides and erosion in the catchment of the Gaula River, Kumaun Lesser Himalaya, India Mountain Research and Development, 9 (4), pp 405-419.

Chaudhry, S. *et al*., 2010. Surface and Sub Surface Characterization of Byung Landslide in Mandakini Valley, Garhwal Himalaya. Himalayan Geology Vol.31 (2). P125.

Gerrard, J., 1993. The Landslide Hazard in Himalaya: Geological Controle and Human Action. *Geomorphology* 10 (4), Pp221-230.

Gupta, V. and Bisht, K.S. 2004. The 23 September 2003 Varunavat Pnrvat Landslide in Uttaranchal. *Current Science*, 87 (11), 1600-1605

Hewitt, K. 1998. Catastrophic Landslide deposits in the Karakoram Himalaya. *Science*. 242. pp 64-77.

Ives, J.D. and Messerli, B. 1981. Mountain Hazards Mapping in Nepal Introduction to an Applied Mountain Research Project. Mountain Research and Development, Vol 1, No 3-4, pp-223-230.

Kohli, A. 2008. Slope Stability Studies Along Kranprayag Gwaldam Road, Garhwal Himalaya, Uttaranchal India. Unpublished D.Phil thesis in Geology, HNB. Garhwal University, Srinagar (Garhwal).

Naithani, A.K. & *et al.*, 2002. The catastrophic landslider of 16 July, 2001 in Phata Byung area, Rudraprayag district, Garhwal Himalaya, India. Current Science vol. 82, No. 8.

Pachauri, A.K. & Pant, M., 1992. Landslide Hazard mapping based on geological attributes. *Engineering Geology*, 31, pp81-100

Pellicani, R., Van Westen, C. J. and Spillotro, G., 2014. Assessing landslide exposure in areas with limited landslide information. *Journal of the International Consortium on landslide*, Vol. 11, No. 3, Pp 463-480.

Restrepo, C. and *et al.* 2009. Landslide and its multi scale influence on Mountainscapes. *Bioscience*, Vol. 59, No. 8 Pp 685-698.

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