Causal and Trigger Factors of Landslide Occurrences in Southern Leyte, Philippines: Its Implications to Disaster Risk Reduction and Management

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Keywords, Rainfall, landslide, Philippines, trigger and causal factors; faultline

1 Introduction

Leyte and Southern Leyte are some of the provinces of the Philippines which had the worst landslide history. Several catastrophic landslides occurred in Leyte, the worst of which were the landslides in Ormoc City, Leyte in November, 1991 and in Panaon island in Southern Leyte on December 19, 2003. These series of massive landslides which claimed the lives of more than 5,000 and 200 people in Ormoc City, Leyte and Southern Leyte respectively were triggered by heavy and continuous rain. On February 17, 2006, massive landslides occurred also in Barangay Guinsaugon, St. Bernard Southern Leyte and more than 1,000 people were buried alive that made it the most catastrophic landslide event in the recent times. On January 2, 2011, landslides hit again the town of Saint Bernard, Southern Leyte which claimed the lives of about 5 people.

Landslides are the most widespread and damaging hazards and are responsible for extensive damages not only in the Philippines but also in many parts of the world. These extensive damages and serious negative impacts underscore the need for landslide studies in landslide-prone areas. However, only few studies are conducted to address problems on landslides under Philippines setting. Research outputs could be used as basis in decision making for land use planners and policy makers.

To answer this need, a study using geospatial technologies (Geographic Information System (GIS), Global Positioning System (GPS) and remote sensing (RS)) was conducted to characterize the bio-physical attributes of Southern Leyte including Panaon island; and make recommendations for policy formulation for the local government.

The major attributes of the province that were mapped were: rock formations and fault lines, seismic occurrences, slope, Digital Elevation model (DEM), Soil series, vegetation and land use and rainfall characteristics. These were sourced – out from the Visayas State University (VSU) GIS Services unit and from PHIVOLCS, PAG-ASA and Regional Environment Information Systems- University of the Philippines (REIS-UPV), Tacloban College.

The results of the characterization based on the digitized geologic map of DENR, showed that the area is dominated with Miocene-andesitic, basaltic and dacitic flows and breccia rock formation which occupied 33.5% (56,063 ha) while the Quaternary and Miocene- coralline limestones occupy 19% (31,864 ha) and 9% (15,313 ha), respectively. This specific geologic formation is found at higher elevations and steep slopes and is associated with the presence of the active Leyte segment of the Philippine fault. This fault structure plays an important role in the geodynamics and kinematics of Leyte and Southern Leyte provinces.

Geomorphologic characterization of the province revealed that highest elevation was 1,000 m asl with steep to very steep slopes (angle > 30°) which are conditions that contribute to landslide occurrence.

The general soil series classification was Rough Mountainous land identified as Maasin series and Rough stony land. These soil series which were considered mountain soils were strictly and strongly recommended to be kept under permanent vegetative (trees) cover and under no condition should be cultivated (Barrera, 1954). However, vegetation analysis showed the dominance of cultivated crops, coconut and abaca (Table 1) which was confirmed and verified during the field survey.

In the Philippines, the occurrence of earthquakes can be considered a causal or trigger factor. Frequent seismicity is one of important characteristics of Southern Leyte province. At least 128 shallow with Ms 2.1 to Ms 5.7 magnitude earthquakes occurred along the Leyte-Segment

Two of the stronger earthquakes were the Ms 6.4 in July 05, 1994 and Ms 5.9 in 1998 still in Southern Leyte. It is significant to note the occurrence of two moderate magnitude earthquakes (Ms 3.3; 6:22 AM and Ms 4.3 at 10:36 AM) on the day (February 17, 2006) of the Guinsaugon landslides. Immediately after the second earthquake, the rockslide-debris avalanche occurred. This active seismicity was attributed to the Leyte segment of the Philippine fault (Daag and Buena, 2006) and is one of the possible trigger factor for the St. Bernard, Philippines landslides.

Moreover, another important trigger factor is rainfall. Records from PAG-ASA showed an unusually high rainfall amount, 853 mm in December, 2003 (Maasin, Phil., PAG-ASA station) and 979 mm in February, 2006 (Otikon, rain gauging station) (Fig. 1). It is significant to note that these were the times when catastrophic landslides occurred in Southern Leyte. Springs which are indicators of instability are also found common in the area.

Landslides generally occurred in the mountainous terrain of Southern Leyte. Initiation zones originated at the ridges near the fault line and at higher elevation with slope angles > 30° (Jadina and Paningbatan, Jr., 2010). The Guinsaugon landslides showed that a 700 m asl mountain had a run-out distance (distance travelled by the landslide materials) of about 4 km. (Catane et al., 2006; Jadina and Paningbatan, Jr., 2010) during landslides.

2 Conclusions

Results of the study showed that landslides are associated with Miocene-andesitic, basaltic and dacitic flows and breccia rock formation, and it generally occurred at the ridges near the fault line, at higher elevation with slope angles > 30°. Fig. 1, Daily and cumulative rainfall (mm) for the month of February, 2006 measured at Otikon, Libagon, Southern Leyte rain gauging station.

In addition, loss of vegetation, seismicity and abnormally high rainfall are factors influencing landslide occurrences. It is strongly recommended that to enhance stability, tree planting should be encouraged in the mountains of Southern Leyte and tree cutting should be completely banned. It is important that danger zones be established and that footslopes of mountainous terrain within this zone should not be used for human settlement.

Acknowledgements

Great appreciation goes to the Southeast Asian Regional Center for Graduate Studies and Research in Agriculture (SEARCA) - Seed Fund for Strategic Research and Training Program (SFRT) for the financial support during the conduct of this study from January, 2010 to January, 2011.

References


