SLOPE MASS MOVEMENTS AND ASSOCIATED SOILS IN EAST KHASI AND JAINTIA HILLS OF MEGHALAYA

ABSTRACT

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The Problem, Objectives and the Study Area :

Slopes are the basic of all landforms and for this reason alone commands the attention of physical geographers. In addition to soil formation slopes directly affect many of man's activities, viz., agriculture, land drainage and major construction which are associated with various kinds of land stability.

Studies on slopes are based on two important concepts viz., form and process. 'Form' applies to the morphology at a given moment of time, and 'process' applies to the happenings and agents active in changing the 'form'. The predominant attributes of hillslope are landform and its composition e.g. soil and rock. Among the various processes the importance of mass movement has been highlighted in many forums. Mass movement is the detachment and downslope transport of soil and rock material under the influence of gravity. The sliding or flowing of these materials is due to their position and gravitational force, but the mass movement is accelerated by the presence of water, ice and air. Thus mass movement considers movements of earth materials at all scales and at all rates. Mass movement occurs when the stresses acting on a hill or a valley side exceed the strength of the material involved. It is reported that the mass movement directly

depends upon the slope angle and strength of the materials. Consequently, the strength of the materials depends on many factors including the role of water. Water in the pore spaces between soil particles or in the cracks of rocks exerts pressure on the surrounding materials. Therefore, water holding capacity, plastic limit and liquid limit which are interdependent factors and are influenced by the texture of the material, are important factors in mass movement. Strength also depends upon its organic matter content, as higher organic matter content reduces cohesion of the soil particles.

Information as to such studies embracing the above factors causing different types of mass movement is very meagre. The main objective of the study will be, therefore, to identify form of slope and types of mass movements that occupy there on, to relate mass movement with slope elements and finally, to investigate relationships between the occurrence of unstable mass movement slopes and their associated soil, and between the occurrence of relatively stable slopes and their associated soils. To throw some light into these aspects, the present study is, therefore, undertaken in Meghalaya, which is famous for tropical monsoon climate having the highest rainfall in the world. The pattern of rainfall distribution is, however, not uniform throughout the year. Geologically, the study area is occupied mainly by

archean gneissic complex, sandstone, shales, limestone etc., which together with peculiar geomorphological setting pose an exclusive field for such study. For this purpose, various sites in East Khasi and Jaintia Hills districts, Meghalaya are included in the study.

Materials and Methods :

1. Physiographic material : Aerial photos of scales 1:60,000 using stereoscope have been interpreted for delineation of broad geomorphic units.

2. Identification of mass movement prone areas : Based on the knowledge gained from aerial photos of the locations having distress instability conditions, field observations are made to examine, identify the slopes and types of mass movements. Slope profile measurements were done with the help of abney level and pit was dug and soil samples were preserved for analysis.

3. Particle size analysis, water holding capacity, liquid limit, organic carbon and pH were determined for each sample as per standard method.

4. Based on severity, types of mass movements observed in this area are scored with numerals 1,2....6.

Description of Sites : Slopes and Soils :

Slope profile and soil analysis were undertaken in ten selected locations. They are Mylliem, Ryngngain, Sohiong, Mawlat, Smith, Barnihat, Jarain, Bapung, Komrrah and Sonapur. The first six are located in old hard rock zone of granites and gneisses. The first five offer dominantly natural landscape. Centrally located Barnihat is a localised areas of Jhum cultivation. The other four are localised areas in the southern fringe lying on the younger soft rocks : sandstone,shales and limestone.

RESULTS & DISCUSSION :

Based on severity, types of mass movement observed in the present investigation are arranged as Topple > wedge slide > rockslide > talus creep > soil creep > sheetwash and scoring with numerals 1,2,3,4,5 and 6 were allowed to indicate progressive increase in severity respectively. The highly significant and positive relationship ($r=0.77$) observed between gradient and severity of mass movement in the present study suggest that with increase in gradient severity of mass movement increases.

However, severity of mass movement does not depend solely on the steepness of the slopes rather slope length and

shape of slope come into play in the mass movement. In the present investigation, highly positive and significant (p=1 % b=.085) relationship between slope length and severity of mass movement suggest that the increase in severity of mass movement along with parallel increase in slope length.

The above explanation lend support to observed slow mass movement e.g. talus creep, soil creep, sheetwash decrease with gradient form 60-3 %,where slope length of different sites varies from 15 m to 90 m. Increase of slope length with parallel decrease of gradient reduces in velocity of falling of soil and rock masses producing slow type of mass movement. The above results suggest that in rapid and moderate type of mass movement, gradient as explained earlier seems to play major role in determining mass movement irrespective of slope length.

In addition to above, the shape of the slope also plays a vital role in occurrence of different types of mass movement. Three different types of slopes were identified. These can be arranged in order of severity of mass movement as rectilinear > convex > concave. It is found that slow mass movement like sheetwash, soil creep occur in convex slope; topples, wedge slide, rockfall occur in the rectilinear, while there is trace mass movement in the concave slope.

However, geology of the existing rocks might have also played role in the severity of mass movement. It is observed that mass movement e.g. topples, wedge slide, rockfall confined to areas (Mylliem, Ryngngain, Sohiong, Mawlat and Barnihat) developed from hard rock types like granite and gneissic complex, while slow mass movement like soil creep, talus creep occurred on soft rock zone (Bapung, Jarain, Sonapur, Komrrah)viz, sandstone,shale etc. The reason may be attributed to variations in heat penetration between types of rocks. But in case of Smith, the above observation does not hold good. Smith, which occurred in hard rock zone, experiences only mass movement viz. sheetwash and soil creep which can be attributed to low gradient.

The study reveals the following important soil properties as regulated by slope.

(i) Thickness of A horizon shows an inverse relationship with gradient.

(ii) Soil colour depends upon their position on slope profile interacting with organic carbon content and local drainage condition. For example, soils of Ryngngain C with high organic carbon gives rise to very dark grayish brown colour (10 YR. 3/2). While imperfectly drained soils of low organic carbon of Komrrah E give rise to yellowish brown

colour (10 YR. 5/6).

(iii) Proportion of finer soil particle to coarser size distribution shows significant negative correlation with gradient. Variation in the ratio amongst in soils are explained by accumulation due to mass movement, particle sorting, shape of slope, aspect, land clearing and management practices.

(vi) Organic carbon tended to decrease with increase of slope. Variation in the above is explained by erosion and mass movement, drainage condition, aspect, clearing of natural vegetation, human disturbances and microbial activities.

(v) Both water holding capacity and liquid limit behaved the trend of either finer soil particles or organic matter content.

(vi) pH distribution does not show any relationship with gradient.