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IPL Project Annual Report Form 2015

1 January 2015 to 31 December 2015

1. Project Title: Capacity building and the impact of climate-driven changes on regional landslide distribution, frequency and scale of catastrophe
2. Main Project Fields: Targeted Landslides: Capacity building, landslide investigation and risk assessment
3. Name of Project leader IGWE Ogbonnaya, Department of Geology, University of Nigeria, Nsukka, igwejames@hotmail.com
4. Core members of the Project: Ifeanyi Oha, Nnebedum Okechukwu, Ikenna Okonkwo
5. Objectives: One of the major objectives is to increase the capacity of Africans to respond to landslide hazard and risk. It is also aimed at determining (2) the actual processes that lead to the initiation of landslides using a slope stability model; (3) to determine the mechanism of the moving mass using a new ring shear apparatus that simulates the mobility of landslides and (4) to generate data that could be used for a future landslide susceptibility map.
6. Study Area: Nigeria, Ghana and Cameroon
7. Project Duration: 3 years

8. Report

9. 1) Progress in the project: Landslides are great hazards in Africa and also an important Quaternary process at Iva Valley, Enugu, Nigeria where over 192 slope failures have been recorded between 1998 and 2011. Investigation revealed the failures were not confined to a single failure mode but ranged from progressive slides and lateral spread to seepage erosion. Slopes in the area are founded on loosely-consolidated, cross-bedded, friable sandstone units with inter-beds of claystone. Laboratory and stability analyses were applied to study the failure mechanisms. To minimize the potential effects of landslides thereby preserve the environment, in-depth understanding of the processes that govern slope behavior and adoption of adequate landslide prevention strategy and measures for landslide hazard mitigation are a necessity. Better results could be achieved through careful analytical studies of the characteristics of landslide prone areas and the provision of useful information regarding possible future phenomena. Slope failures and obstacles to landslide-hazard reduction at Iva Valley, Enugu, Nigeria, were assessed. A procedure encompassing field, laboratory and numerical analyses was employed in the study. Field studies identified 143 landslides, which were shallow, short run-out movements and some avalanches with run-out distances approaching 3 km. The

slides are triggered by water infiltration in slopes with high topographic gradient. The soil saturation leads to a reduction of the shear strength of the soil because of a rise in pore water pressure. These landslides are known to occur during intense, short duration rainfalls concentrated at the beginning of rainy season. Laboratory data showed that all the specimens responded to shearing in a strain-softening pattern; and as normal stress and OCR increased, there was no transition from contractive to dilative behavior. Normally and over-consolidated specimens showed little difference in their brittleness indices. Numerical analysis simulated the strain-softening behavior of the soil by using strength reduction technique. The structure of the soil mass involved in the sliding, run-out distance and distribution area deduced from the simulation are found to be very similar to those observed. The results of the analysis show that a progressive failure occurred owing to the characteristics (loosely consolidated, unstable, friable sands) and excess pore pressure generation. Finally, the research found that the groundwater level at the onset of rainy season was about 9 m. The level rises (as evidenced by the increase in the yield of springs) during rainy season to alter the stability of the slopes. Matric suction may therefore be the principal force keeping the stability of the unconsolidated materials in the six-month dry regime. Most landslides in the area occur at the beginning of rains because infiltrating water reduces the suction in the slopes.

2) Planned future activities or Statement of completion of the Project: It is our desire to deliver the first, reliable and accurate landslide susceptibility/ hazard zonation map to West Africa and Africa. We also intend to make sure Africa remains visible in the radar of landslide research. We hope to be able to attract students and professionals to our landslide research centre in Nigeria to elevate our expertise and increase hazard awareness in the region. This will take a minimum of 2 more years to achieve. We are making progress and will get there soon. The planned activities are to: (1) investigate the effect of variable water content on the shear behavior of the loose regolith, (2) use infinite slope stability model to understand the influence of moisture and slope angle on Factor of Safety and (3) employ the concept of threshold pore pressure in clear explanation of slide initiation, and its transformation into flow, (4) to produce a landslide susceptibility map which will be a first in Africa. The increase in pore pressure and weight resulting from infiltration of rainwater is the main mechanism of slope destabilization and failure initiation. After initiation, weather a material slides or flows will again substantially depend on the moisture content or saturation level of the moving mass. Although most landslides occur in mountainous regions, some have occurred in low-lying and near-flat terrains by means of lateral spreading, which highlights the importance of pore pressure in slope stability analysis.

3) Beneficiaries of Project for Science, Education and/or Society: Africans and ICL are the major beneficiaries. However, the direct benefits go to the poor people who live at the most vulnerable places in Africa.

10. Results: Igwe O (2015) The study of the factors controlling rainfall-induced landslides at a failure-prone

catchment area in Enugu Southeastern Nigeria using remote sensing data. Landslides DOI 10.1007/s10346-015-0627-9. At the moment, the geologic maps have been produced from data gathered during field work, with inputs from satellite data. A line of section which traverses the known landslide location was selected in order to produce a cross section of the geologic map. During field survey, attempt was made to record the characteristics of the failed masses following laid down recommendations, while the failures were classified according to the recommendations of international standards. The topographic data were generated from 1:50,000 scale standard topographic maps. Detailed geomorphologic mapping with aerial photos was also used to characterize and delineate rock units and possible geologic structures such as bedding planes, joints, and faults. Particle size analysis of the soils was carried using the Unified Soil Classification System (USCS).