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Effect of Climate Change on Rainfall Induced Failures for Embankment Slopes in Timor-Leste

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Abstract : Rainfall induced slope failures are one of the most damaging and disastrous natural hazards which occur frequently in the world. This type of sliding mainly occurs in the zone above the groundwater level in silty/sandy soils. When the rainwater begins to infiltrate into the vadose zone of the soil, the negative pore-water pressure tends to decrease and reduce the shear strength of soil material. Climate change has resulted in excessive and unpredictable rainfall in all around the world, resulting in landslides with dire consequences to human lives and infrastructure. Such problems could be overcome by examining in detail the causes for such slope failures and recommending effective repair plans for vulnerable locations by considering future climatic change. The selected area for this study is located in the road rehabilitation section from Maubara to Mota Ain road in Timor-Leste. Slope failures and cracks have occurred in 2013 and after repairs reoccurred again in 2017 subsequent to heavy rains. Both observed and future predicted climate data analyses were conducted to understand the severe precipitation conditions in past and future. Observed climate data were collected from NOAA global climate data portal. CORDEX data portal was used to collect Regional Climate Model (RCM) future predicted climate data. Both observed and RCM data were extracted to location-based data using ArcGIS Software. Linear scaling method was used for the bias correction of future data and bias corrected climate data were assigned to GeoStudio Software. Precipitations of wet seasons (December to March) in 2007 to 2013 is higher than 2001-2006 period and it is more than nearly 40% higher precipitation than usual monthly average precipitation of 160mm.The results of seepage analyses which were carried out using SEEP/W model with observed climate, clearly demonstrated that the pore water pressure within the fill slope was significantly increased due to the increase of the infiltration during the wet season of 2013.One main Regional Climate Models (RCM) was analyzed in order to predict future climate variation under two Representative Concentration Pathways (RCPs).In the projected period of 76 years ahead from 2014, shows that the amount of precipitation is considerably getting higher in the future in both RCP 4.5 and RCP 8.5 emission scenarios. Critical pore water pressure conditions during 2014-2090 were used in order to recommend appropriate remediation methods. Results of slope stability analyses indicated that the factor of safety of the fill slopes was reduced from 1.226 to 0.793 during the dry season to wet season in 2013.Results of future slope stability which were obtained using SLOPE/W model for the RCP emissions scenarios depict that, the use of tieback anchors and geogrids in slope protection could be effective in increasing the stability of slopes to an acceptable level during the wet seasons. Moreover, methods and procedures like monitoring of slopes showing signs or susceptible for movement and installing surface protections could be used to increase the stability of slopes.

Keywords : climate change, precipitation, SEEP/W, SLOPE/W, unsaturated soil
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