POTENTIAL DAMAGE ZONE PREDICTION OF RAIN-INDUCED RAPID AND LONG TRAVELING LANDSLIDES IN SRI LANKA, BASED UPON DEBRIS FLOW ANALYSIS COMBINING CELLULAR AUTOMATION AND MULTI-AGENT MODELS

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Purpose: A Landslide is one of the geo-dynamic processes that naturally shape the geomorphology of the earth. Among various natural hazards, landslides have been attracting increasing attention worldwide due to their increasing and serious impacts on human lives and the economy. Currently, major measures for landslide disaster management taken by the National Building Research Organization, Sri Lanka are (1) landslide susceptibility mapping based upon terrain factors (2) issuing landslide warnings and relaying them timely to the last mile, namely communities at risk through the Disaster Management Centre with community-based networks and (3) evacuation practices. The accurate potential damage zone prediction is a pressing need through the geospatial highlighting of downslopes vulnerable to landslides.

Methods: Assessing the geospatial susceptible zones for landslide initiations is introduced through the combining approach of the geomorphological hill-shade with slope map analysis by ArcGIS and the highest landslide susceptibility zones from Landslide susceptibility maps produced by the National Building Research Organization. The next step is to predict the potential damage zone in downslopes. The complete mechanism of unstable mass movement is investigated through the analysis of (1) the debris distribution variation along the landslide runout by the combining approach of picture-based analysis and sieve analysis, (2) the debris propagation mechanism by flume test, (3) surface morphology by Light Detection And Ranging data, and (4) stopping mechanism through mobility index. The multiple surveys and investigations of pilot sites that were introduced from the SATREPS project; Aranayake, Athweltota, and some more in Japan are used for the model development. Those listed above are important data for the simulation of the runout distances of Rain-Induced Rapid and Long Traveling Landslides. For these simulations, we will develop a combined model using Cellular Automaton (CA) and Multi-Agent (MA) models. The mechanical features of the soil/debris will be implemented in the local interaction rules that describe interactions among neighboring agents (soils, water, etc.) on the grid structure of the Cellular Automata model. These models are promising to allow us to simulate the flows of fluidized debris slurries which are often mixtures of water, sand, gravel, etc., and will be described as agents in each cell on the grid structure of Cellular Automation covering the 3D terrain of the target area.

Results: The main outcomes of the study are the geospatial susceptible zones for landslide initiations and the potential damage zone prediction of Rain-Induced Rapid and Long Traveling Landslides. The importance of this approach can be described as the combined model of Cellular Automaton and Multi-Agent leading to time-saving through multiple point simulating and using local interaction rules for simulating. The accuracy of this combined model will be evaluated by the overall evaluation factor (Ω) through back analysis of pilot sites.

Conclusions: Developing the method combining Cellular Automaton and Multi-Agent models to simulate downslope movements of fluidized debris mass is thus vital for assessing potential damage zones and will help disaster management activities in not only Sri Lanka and Japan but also other countries suffering from heavy rains.