Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HTT09-13 Room:102A Time:May 20 17:30-17:45

Geospatial simulation of tsunami evacuation using agent-based modeling

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In the last decades, applications using agent-based modeling (ABM) and geographical information systems (GIS) have increased. Previously, GIS was focused on representing the world as the static aggregation of population holding information that was queried and cross-related by the user. Therefore, for years one of the main criticisms to the past GIS models is the use of largely homogeneous entities with the same characteristics (e.g. population). However, certain systems cannot be represented only statically. Most of the social phenomena fall into the category of complex and dynamic systems. To understand such systems with its geographical features (e.g. congestion, segregation, risk), agent based models have contributed on the simulation of human systems and their individual behavior and decisions. Thus, with the integration of ABM models, capable of exploring the system at the level of their constituent elements (agents); plus the GIS technology, suitable for the spatial representation of the world; much more social phenomena can be more adequately represented and simulated.

Geographical Information Systems (GIS) contain powerful tools to analyze phenomena in nature that are particularly static and in some cases dynamic. For years, temporal representation has been a challenging task in GIS platforms. However, application programming interfaces (APIs) allow the use of GIS tools as optional libraries on software. Then, GIS data and tool routines can be imported or linked to simulations of other nature. An example of this is the multiagent programmable modeling environment known as NetLogo. The library extension of GIS permits the use of spatially projected data into the NetLogo world for agents to recognize them in the space.

This study aims on the integration of GIS urban data and the spatiotemporal tsunami numerical simulation output database into an agent based model of human behavior for tsunami evacuation. Agent-based modeling is a powerful technique to simulate social phenomena such as tsunami evacuation. Each agent or evacuee evaluates the surrounding environment provided by the spatial and temporal data to schedule and adjusts his actions. The tsunami propagation inland and its features are updated at each simulation step to evaluate the human body instability using the inundation depth and velocity.

The geospatial simulation of individuals during tsunami evacuation and the analysis of the emergent behavior and outcomes will contribute on the decision process for future tsunami mitigation measures.

Keywords: tsunami evacuation, geospatial simulation, evacuation model, agent based model