A GIS-BASED SIMULATION MODEL OF INFORMATION TRANSMISSION FOR TSUNAMI EVACUATION AND REFUGEE REACTIONS

Toshitaka Katada
Associate Professor, Department of Civil Engineering, Gunma University
1-5-1 Tenjin-cho, Kiryu, Gunma, 376-8515 JAPAN
Phone: +81-277-30-1651 Fax:+81-277-30-1601
katada@ce.gunma-u.ac.jp

Noriyuki Kuwasawa
Researcher, Nippon Koei CO., LTD.

Harry Yeh
Professor, University of Washington

Shun-ichi Koshimura
Researcher, Disaster Reduction and Human Renovation Institution

Akichika Ishibashi
Senior Researcher, Nippon Koei CO., LTD.

Unlike other types of natural hazards, a tsunami can affect very broad regions since it can propagate more than several thousand kilometers across the oceans without losing its energy. Its genesis is unpredictable and unobservable because it occurs under the sea. It is a rare event, and the behaviors and characteristics are quite distinct from other coastal hazards (such as storm waves). Unfortunately, the normally quiescent coastal areas that are struck by tsunamis are also preferred sites for human habitation. Because of these unique factors, mitigation measures for tsunamis must rely on the first-order defense, i.e. evacuation of people from tsunami inundation areas to save human life. From this view point, tsunami warning and its information transmission to the individuals are critical.

We have developed a GIS based tool to simulate information transmission from the authorities to the general publics. The simulation system was originally developed for the other type of natural hazard, i.e. flood. None the less, the lead time for tsunami evacuation is much shorter than the case of flood. For distant tsunami, the lead time can be as long as 24 hours (e.g. the 1960 Chilean Tsunami in Japan). For a near-source tsunami, it can be a few minutes (e.g. the 1993 Okushiri Tsunami) to about an hour (the 1992 Nicaragua Tsunami). The short lead time for tsunami makes evacuation challenging and information transmission to the general publics must be effective and efficient. Our simulation system is useful to make improvement in tsunami evacuation strategies by applying it as a scenario simulator. It can also used effectively to diagnose the existing tsunami emergency evacuation plans.

Our simulation system is based on the Biased Network Model, that is often used for the human network analysis in the field of mathematical sociology. The model includes a variety of transmission means including loudspeakers both fixed and mobile attached to police or fire vehicles and helicopters, individual communication network via telephone lines and oral communications, as well as mass media such as radio and television broadcasting (Fig.1). We

integrate such communication means in our GIS framework so that the information transmission patterns can be conveniently visualized both quantitatively and dynamically (Fig.2). The visualization is critical for the users to grasp the local and global information transmission patterns for the rational evaluation. After the simulation, all the relevant functional parameters are computed and presented as the time-series data for further evaluation. Our simulation system is still in a developing stage and needs to evolve further, for example, human psychology as well as cultural elements can be incorporated in the future model. None the less, the framework for the useful evaluation tool is establish for the first-order mitigation measures against potential tsunami attacks.

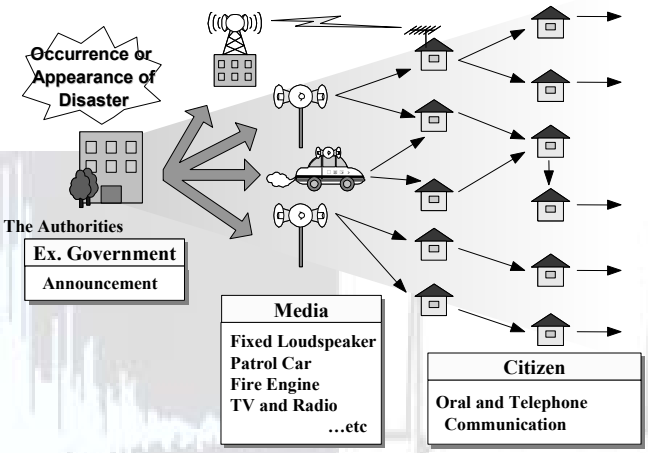

Fig.1 The Basic Structure of Simulation

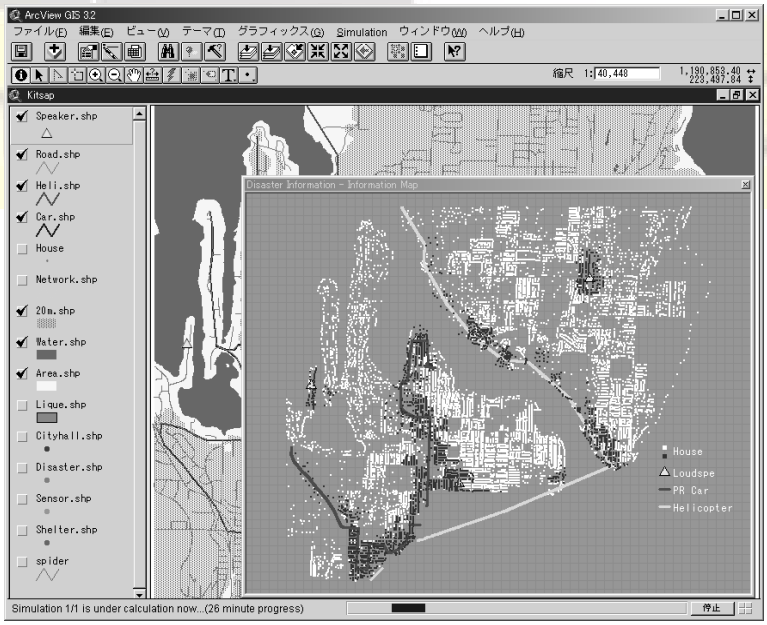

Fig.2 A typical simulation on GIS