Lessons of the 2011 Tohoku Earthquake and Tsunami with Low Frequency and High Impact and Developing Numerical Modeling for Future Disaster Risk Reduction

Fumihiko IMAMURA

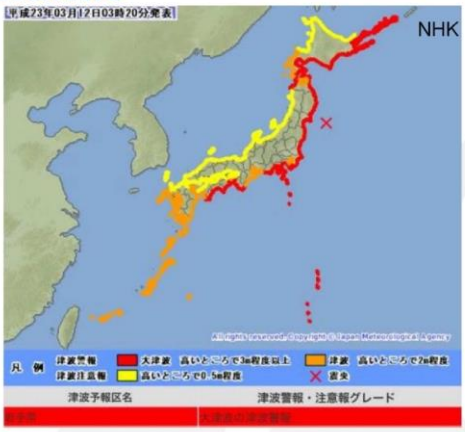
Director of International Research Institute of Disaster Science and Prof. of Tsunami Engineering, Tohoku University, Japan

Email: Imamura@irides.tohoku.ac.jp

ABSTRACT

The huge tsunami generated by the 2011 Tohoku earthquake more than M9.0, causing serious damages, was beyond our experiences and much larger than the estimated one in Tohoku region, Japan. The inundation area of the 2011 Tohoku at many areas in coastal area exceeds those on the hazard map based on the assessment with historical evidences in Japan, causing more casualties in the 2011. The people tried to evacuate toward outside of estimated inundation area but the tsunami trapped them. The experiences among survivors including the traffic condition along the coast as well as the information of casualty by local government are compiled to find out the situation of evacuation process and the solutions to save our lives at that period, which should be shared as the lessons learnt are for disaster risk reduction in future to make resilient city. The numerical model of evacuation using the multi-agent for pedestrian–car interaction has been applied for the planning in the target area. Moreover the tsunami widely observed and recorded on the affected area were no longer sea water but muddy one with strong current containing sediments near shore and on the land, changing the topography; erosion and depositions along the coast. The debris such as parts of houses, infrastructures, plant, woods, cars and ships moved by tsunami currents are new target in the tsunami simulation. Therefore, we make great efforts on developing the new integrated simulation of tsunamis with multi-scenario and complex feature including sedimentation on the coast. Fragility analysis of tsunami characteristic such as tsunami inundation height, flow depth or velocity against human fatality, damage on building, fishery boat, pine tree and pedestrian bridge are also carried out and is going to be included on.

- **Triple Disasters: TWO – Tsunamis**
  - Tsunami evacuation order and warning, immediately after – all around coastal Japan
  - Time reaching the coast: less than 20-30 min
  - 7 tsunamis in the first 6 hrs after the shock, continue for 2 days



- According to the information:
  - Highest wave recorded: 9.3m
  - Highest run up-height : 35 m
  - Farthest inland reached: 8km

ku.ac.jp/ IRIDeS International Research Institute of Disaster Science

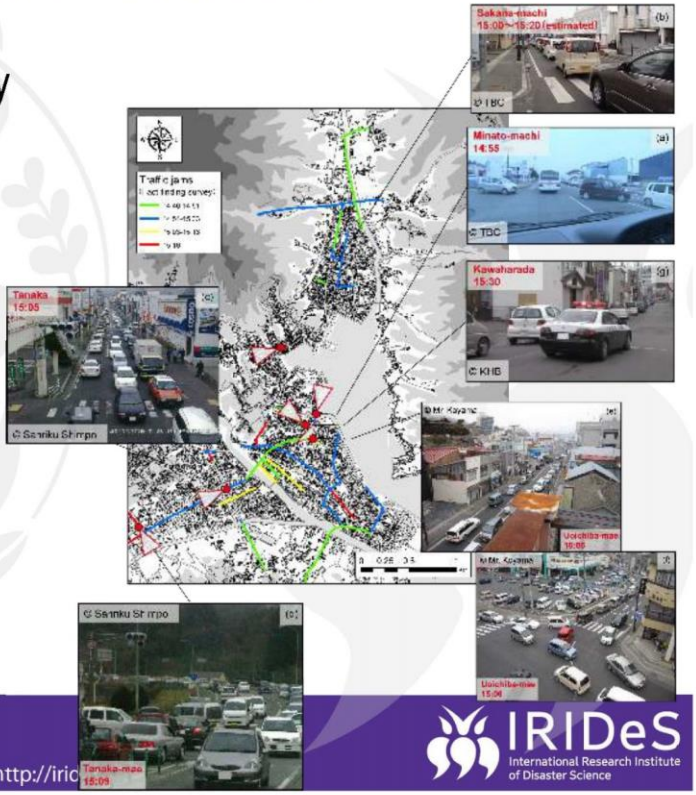
Other damages

- Inundated area: 560km2
- Liquefaction
- Erosion, deposition due to sedimentaion
- Fire

Survey on evacuation behavior in Kesennuma

- Organized existing survey results
- Collected media source recording evacuation evidences

>> These revealed more realistic behaviors and enabled evacuee modelling



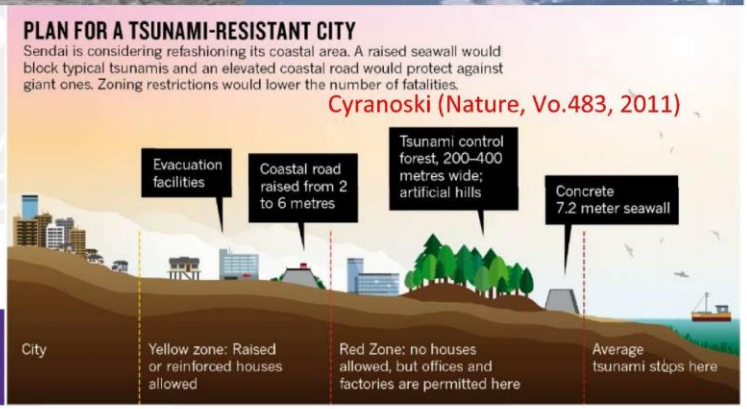
TOHOKU UNIVERSITY

http://iric

IRIDeS International Research Institute of Disaster Science

Past Protections in Multi-layers, Damage by the 2011 and Plan for Tsunami Resilient city in Sendai

Only two temples were damaged among 100 with 1,000 years history in the affected area



TOHOKU UNIVERSITY