Development of risk assessment simulation tool for optimal control of a low probability – high consequence disaster

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【1. Introduction】

➢risk assessment for primary earthquake hazards (strong shaking, tsunami etc.) has been investigated and they have been applied in earthquake insurances and the business continuity plans (BCP) of companies.

➢However, no system are able to handle multifarious and multitiered secondary effects of earthquakes such as great damages by tsunami, radioactive contamination caused by the nuclear power plant accident, and the impacts of the shredded supply chains on the industry.

➢Therefore, there is an urgent need of constructing comprehensive, interdisciplinary simulation technologies of risk assessment to estimate the multitiered effects of primary hazards and secondary damages and to assess the risks of damages in order to help people take the optimum actions during a low-probability but high consequence disaster, which may cause huge economic and social damages.

➢The National Institute of Advanced Industrial Science and Technology will start an interdisciplinary study in this year, cooperation of the Active Fault and Earthquake Research Center, which has a potential of assessing earthquake hazards, and the Research Institute of Science for Safety and Sustainability, which have been developing chemical and environmental risk assessment tools.

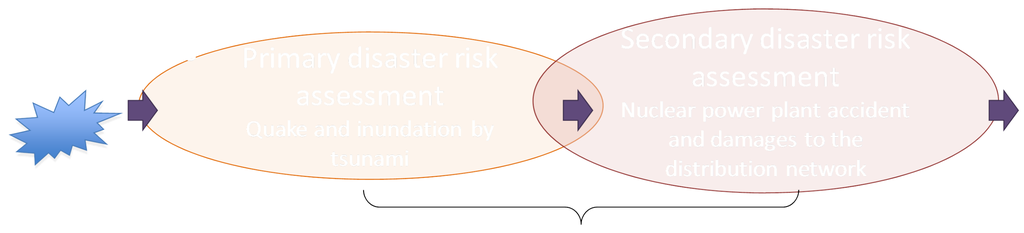


Figure 1. Position of next-generation risk assessment simulation technologies

【Framework of the study】

Comprehensive risk assessment simulation technologies are to be researched, developed and provided aiming to prevent or mitigate the direct primary damages caused by large-scale earthquakes and tsunami and relevant and indirect secondary damages, such as nuclear power and chemical plant accidents and destruction of production and distribution network.

(1) The subsystem for estimating the primary disasters;
estimating the earthquake intensities in the major industrial zone

(2) The subsystem for quantifying the hazards of secondary disasters;
quantifying the damages to the transportation network and lifelines, fire damages, and diverse damages to the industries caused by disturbance to the production and distribution network across regional and national boundary as well as the damages of human health caused by spread of radionuclides and toxic chemical substances by nuclear power and chemical plants accident.

(3)The risk assessment subsystem;
simulating the risk of loss of lives, destruction of houses and fire damages

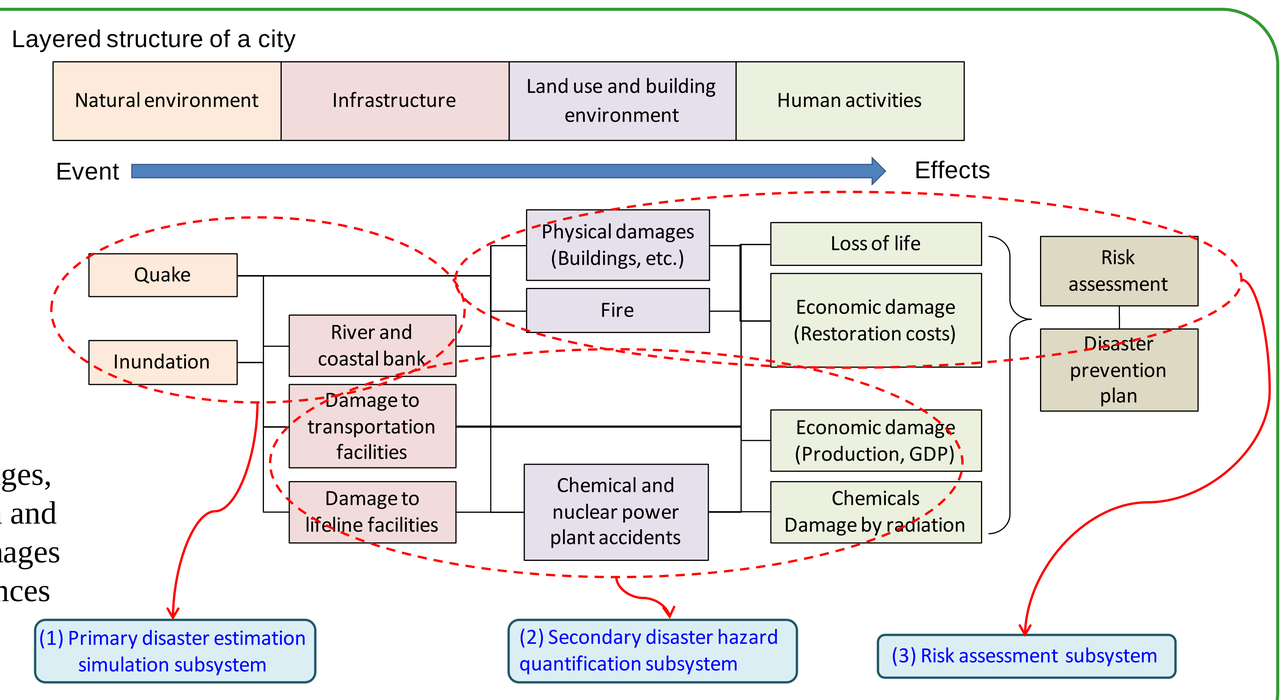
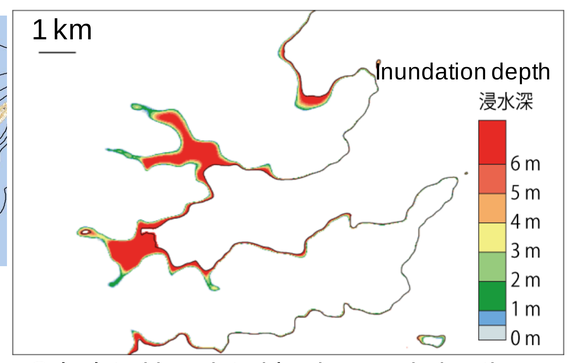


Figure 2. Framework of the risk assessment simulation system

【 (1) The subsystem for estimating the primary disasters】

➢The earthquake intensities during an earthquake and the degree of inundation by tsunami are to be used as the inputs of the risk assessment simulation.
➢The inputs of the system need be clarified in advance because the output level of the analysis may vary depending on the requirements to the inputs.

Depth contour (for each 20 m) added to a terrain map of of Otsuchi Bay, Iwate Prefecture



Calculated inundated land areas during the tsunami using an earthquake source model. Inundation depth denotes the depth of water over the ground surface.

Figure 3. Output image of tsunami calculation

【 (3)The risk assessment subsystem 】

➢Risk analysis will be conducted by using the three parameters of hazard, exposure and vulnerability. The risk assessment simulation technologies are to be developed so as to use the results of the assessment for deciding disaster prevention plans and risk management .
➢the entire process including the primary to secondary disasters will be first analyzed.
➢Disaster prevention plans will also be surveyed aiming to provide information for high cost effective disaster prevention investment.
➢The ways of assessing the risk of low-probability but high-consequence disasters will also be investigated.

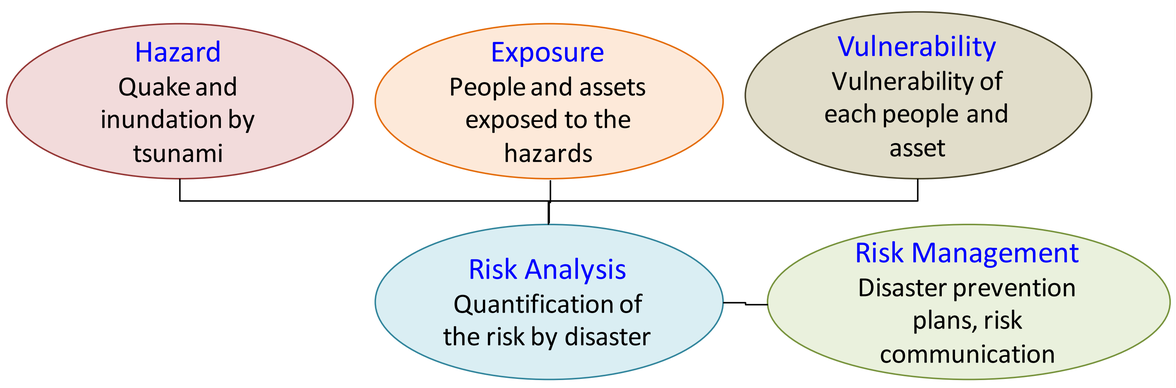


Figure 4. Concept of the seismic risk management system

【 (2) The subsystem for quantifying the hazards of secondary disasters】

1) Quantification of the hazards of toxic chemicals and radioactive substances

➢Accidents and events in the past are to be surveyed and analyzed, and detailed event trees will be prepared to show the process from the generation of the accident to damages.
➢The constituents of each event will be quantified for the development of the models and their parameters.

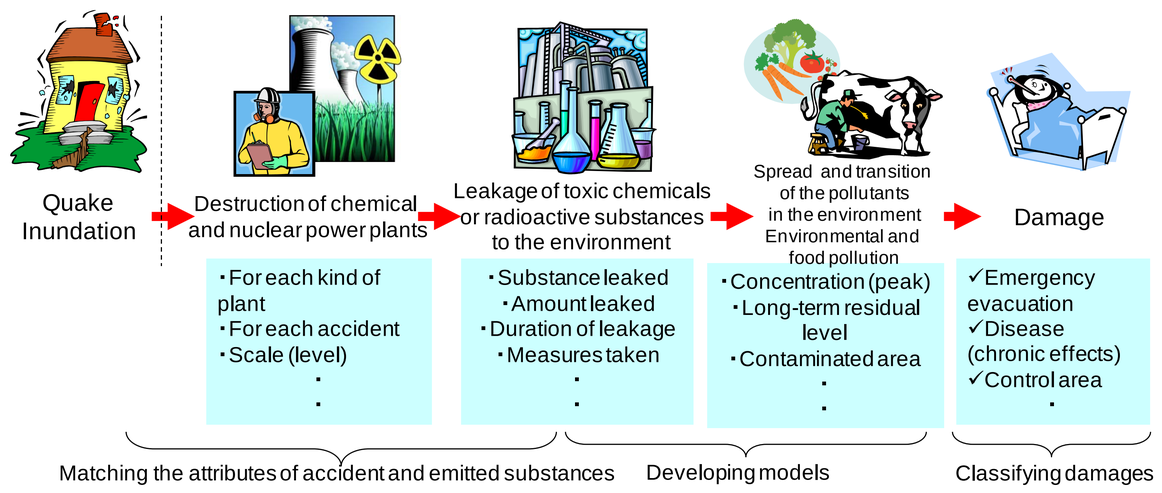
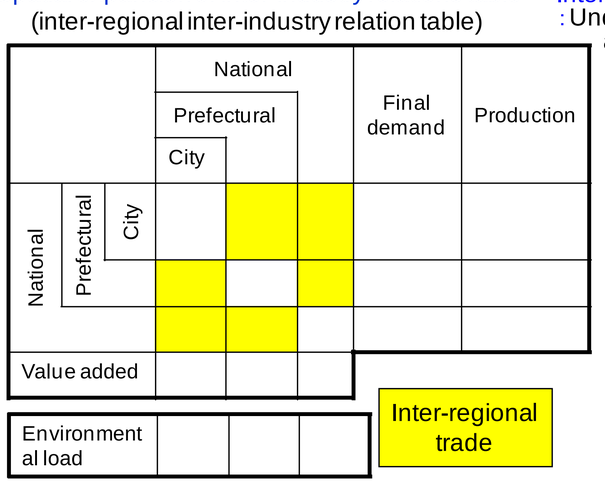


Figure 5. Schematic diagram of dynamic model development of an environmental system feasible for analyzing instantaneous massive leakage and resultant long-term pollution

2) Investigation of secondary damages by analyzing industrial supply chains

➢We will extract industries and supply chains that are possibly affected by the anticipated Tokai and Tonankai Earthquakes.
➢Methodologies will be established for automobile, chemical and semi-conductor industries, which are likely vulnerable.

Spatial expansion of inter-industry relations table
(inter-regional inter-industry relation table)



Inter-regional and inter-industrial material flow matrix
: Understanding the interchange properties of each region and industry

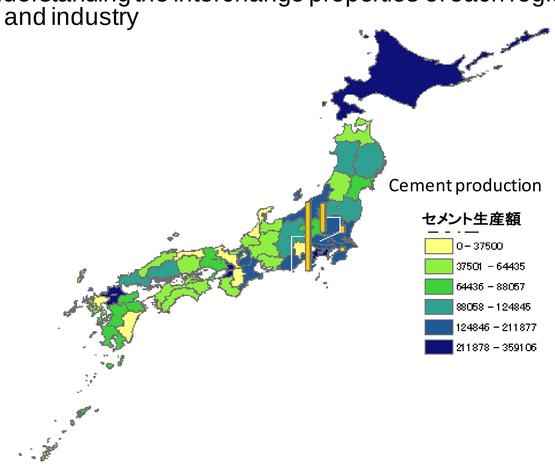


Figure 6. Concept of inter-industry relations analysis