

Research Axis 2  
Human Activity  
Impact Assessment

## Human Impacts on Urban Subsurface Environments

This project will assess the effects of human activities on the urban subsurface environment, an important aspect of human life in the present and future but not yet evaluated. This is especially true in Asian coastal cities where population numbers and density have expanded rapidly and uses of subsurface environment have increased. The primary goal of this project is to evaluate the relationships between the development stage of cities and various subsurface environmental problems, including extreme subsidence, groundwater contamination, and subsurface thermal anomalies. We will address the sustainable use of groundwater and subsurface environments to provide for better future development and human well-being.

Project Leader ■  
Core Members ■

**TANIGUCHI, Makoto** RIHN

**EHARA, Sachio** Graduate School of Engineering, Kyusyu University  
**YOSHIKOSHI, Akihisa** College of Letters, Ritsumeikan University  
**YAMANO, Makoto** Earthquake Research Institute, Tokyo University  
**FUKUDA, Yoichi** Graduate School of Science, Kyoto University  
**KANEKO, Shinji** Graduate School for International Development and Cooperation, Hiroshima University  
**ADACHI, Itsu** Japan International Cooperation Agency  
**TOKUNAGA, Tomochika** Graduate school of Frontier Sciences, Tokyo University  
**SHIMADA, Jun** Faculty of Science, Kumamoto University  
**ONODERA, Shin-ichi** Faculty of Integrated Arts and Sciences, Hiroshima University  
**NAKANO, Takanori** RIHN

### Objectives of this project

Securing water resources and clearing contaminated water caused by human activities in urban areas are global environmental issues in the 21<sup>st</sup> century. Heat island phenomena created by human activities is also a big environmental problem in addition to global warming. These

global environmental issues, which are caused by urbanization, should be addressed strongly and prevented, because population increase and concentration occurs rapidly in urban areas.

Most global environmental studies have long been focused on the environmental issues above ground surface such as:

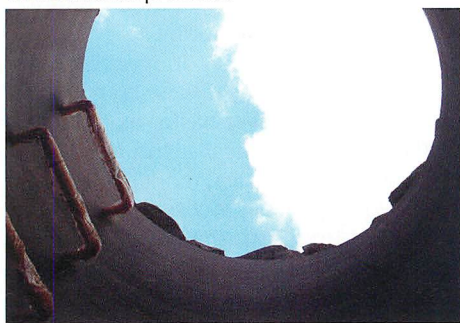
air pollution, global warming, seawater pollution, and decrease in biodiversity. Subsurface environmental issues are also important for human life for the present and future, but have been largely ignored because of the invisibility of the phenomena and difficulty of the evaluations.

Subsurface environmental problems such as subsidence due to excessive pumping and groundwater contamination have occurred repeatedly in major Asian cities, with a time lag depending on the development stage of urbanization. Therefore, we may be able to assess future scenarios if we can evaluate the relationships between subsurface environmental problems and the development stage of the city.

### Study area and methods

This project will deal with; (1) Relationships between the development stages of the cities and subsurface environmental problems will be

Window to find subsurface environmental problems



We will evaluate the changes of subsurface environment which has not studied yet.

Figure 1 Development Stage of the Cities

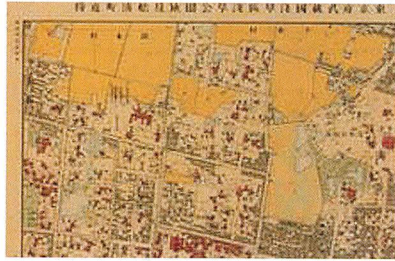


We will evaluate the driving force which causes the changes of subsurface environment in each developing stage of the cities.



Figure 2 Methodology of the Four Sub-themes

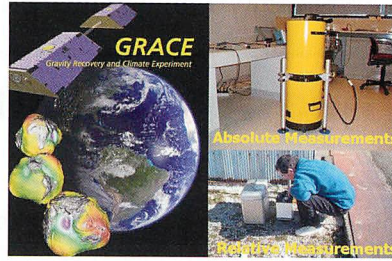
Reconstruction of water environment by uses of historical records



Evaluations of nutrient transports by groundwater to the coast



Evaluations of change in groundwater storage through gravity measurements

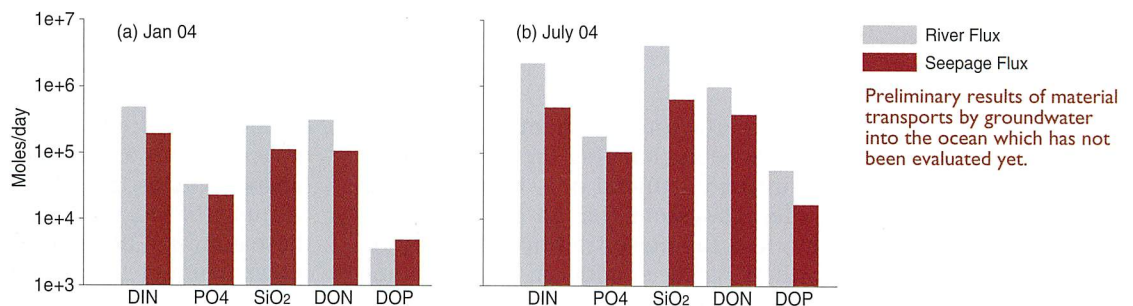


Soil temperature measurements



We will use both (1) reconstruction and inverse method (from present to the past) and (2) monitoring, modeling and simulations (from past to present and future)

Figure 3 Preliminary Results of Estimated Fluxes in the Flow of Inorganic and Organic Nutrients into the Upper Gulf of Thailand via the Chao Phraya River (slashed) and Groundwater (brown)



assessed by socio-economical analyses and reconstructions of urban areas by uses of historical records; (2) Serious problems in subsurface environments and changes in reliable water resources will be studied after evaluations of groundwater flow systems and changes in groundwater storage by uses of hydrogeochemical data and in-situ/satellite-GRACE gravity data; (3) We will also evaluate the accumulation of materials (contaminants) in the subsurface and their transports from land to the ocean including groundwater pathways by uses of chemical analyses of subsurface waters, sediments and tracers; and (4) Subsurface thermal contamination due to the "heat island" effect in urban areas will be evaluated through the reconstruction of surface temperature history and urban meteorological analyses.

Tokyo, Osaka, Bangkok, and Jakarta are targeted as study cities, and Taipei, Manila and Seoul are selected as secondary study cities depending on the four sub-themes. The project will focus on the urban subsurface environments; however, we will treat the problems on a basin scale, because subsurface water, heat, and material transports are interconnected on this scale. We will focus on the relationships between

subsurface environmental changes and human activities during the past 100 years.

### Progress of the project

- Preliminary field surveys at Seoul, Taipei, Bangkok, Jakarta, Tokyo and Osaka have been made.
- International Symposium on "Human Impacts on Urban Subsurface Environment" was held, and the proceeding was published (Oct, 18-20, 2005).
- The MOUs between RIHN and Research Center for Geotechnology, Indonesian Institute of Science, and Institute of Earth Sciences, Academia Sinica, Taiwan, became effective
- Assessments of existing data in the study areas have been started.
- Preliminary model developments for GRACE (Gravity Recovery and Climate Experiment) data to evaluate the changes in groundwater storage have been made.
- Preliminary evaluations of material transports by groundwater to the coastal zone have been made.
- Cooperation with international research agencies (UNESCO- GRAPHIC (Apr.2006), GWSP-Asia (Aug.2005) has begun.