

# 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.

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## (I) Objectives of this project

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 in 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, groundwater contamination, have occurred repeatedly in Asian major 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.

This project will deal with; (1) Relationships between the development stages of the cities and subsurface environmental problems will be 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 accumulations of the materials (contaminants) in subsurface and their transports from land to ocean including groundwater pathways by uses of chemical analyses of subsurface waters, sediments and tracers; and (4) Subsurface

Figure 1 Schematic Model of This Project

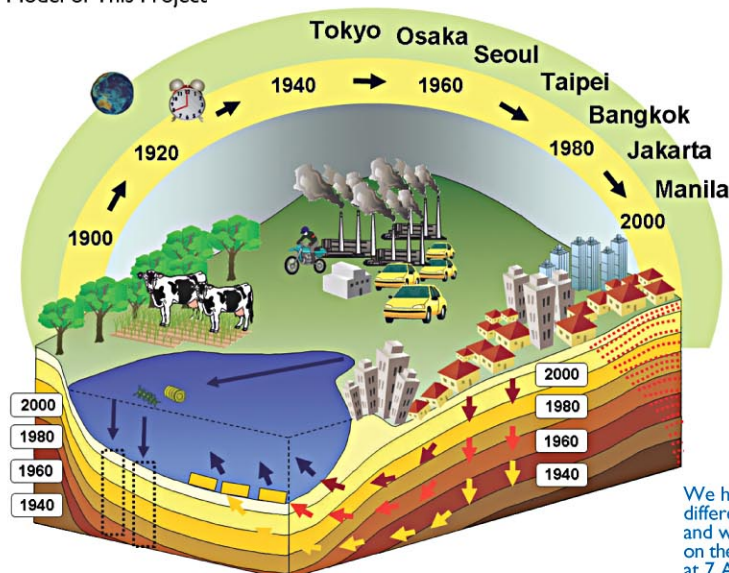
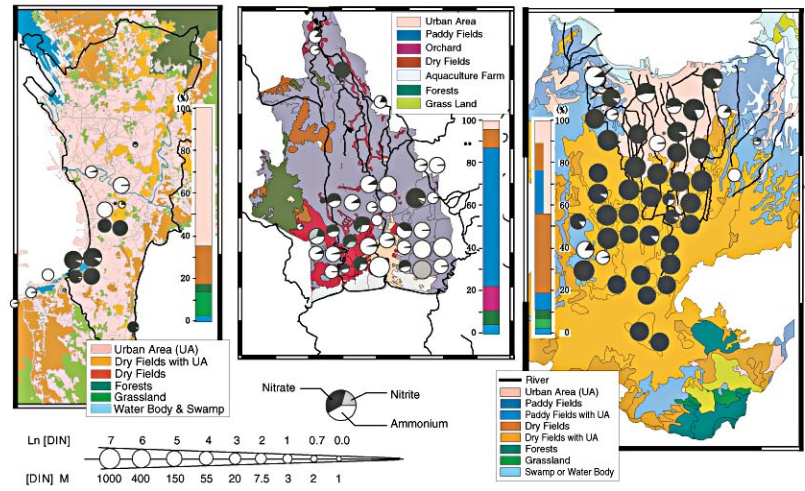


Photo 1 A children drawing well water at Jakarta



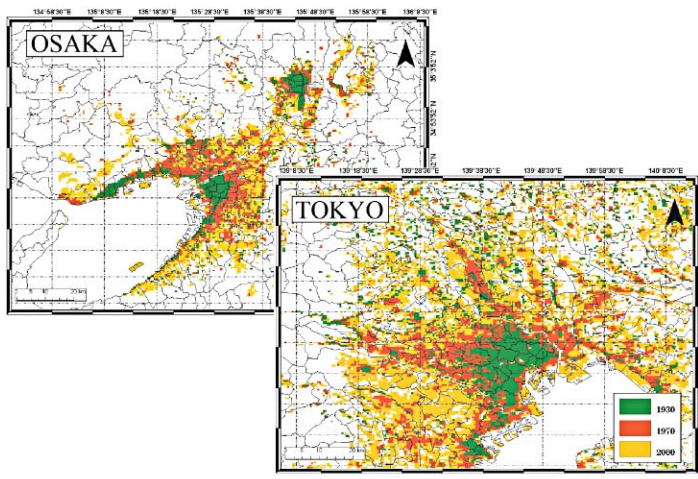
What can we do for conservation and sustainable use of groundwater?

Figure 3 Groundwater pollutions in Asian cities



Magnitudes and composition ratios of Nitrate, Nitrite, and Ammonium pollutions of groundwater at Manila (left), Bangkok (middle), and Jakarta (right).

Figure 2 Expansions of urban area at Tokyo and Osaka from 1930 to 2000



Changes in land cover/use due to urbanization are used for analyses of subsurface environment in Asian cities based on GIS.

thermal contamination due to the “heat island” effect in urban areas will be evaluated by reconstruction of surface temperature history and urban meteorological analyses.

## (2) Progress of the project

- Field surveys on subsurface environment in targeted cities have been made (12 times in 2007), and monitoring of subsurface environments have been going on.
- Assessments of natural and social data in each city, and the structure of project database based on GIS have been made.
- Land cover/use maps based on GIS with 0.5 km mesh have been made at three development stages of Tokyo and Osaka, and current stage of other five cities.
- 2<sup>nd</sup> International Symposium of this project was held at Bali on Dec. 2007 (which was authorized as side event of COP13), and the proceeding of the symposium was published.
- Results on the impacts of climate change and heat island was published as a special issue of International Journal (VZJ), and was cited by Open Science News “Scitizen”.

- Cross cutting theme such as relationship between religion and groundwater has been started in Bangkok and Jakarta.
- Preliminary models such as GRACE, groundwater flow, and DPSIR+C have been established in each sub theme.
- In order to evaluate the origin and process of material loads to subsurface, isotopes and chemical analyses of water samples have been made, and new tracers (CFC, Kr etc.) techniques have been introduced.

## (3) Future works and challenges

- In order to present the interim results of the project, special issue of STOTEN (Science of Total Environment, Elsevier) will be prepared.
- New approaches on the relationship between law/institution and groundwater (private water) /surface water (public water) will be launched.
- New working group will be launched to evaluate an integrated model and indicators.
- New observation system by uses of CFC, KR and absolute gravity measurement will be tested, and inter comparison with different observation methods will be operated.