

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 the 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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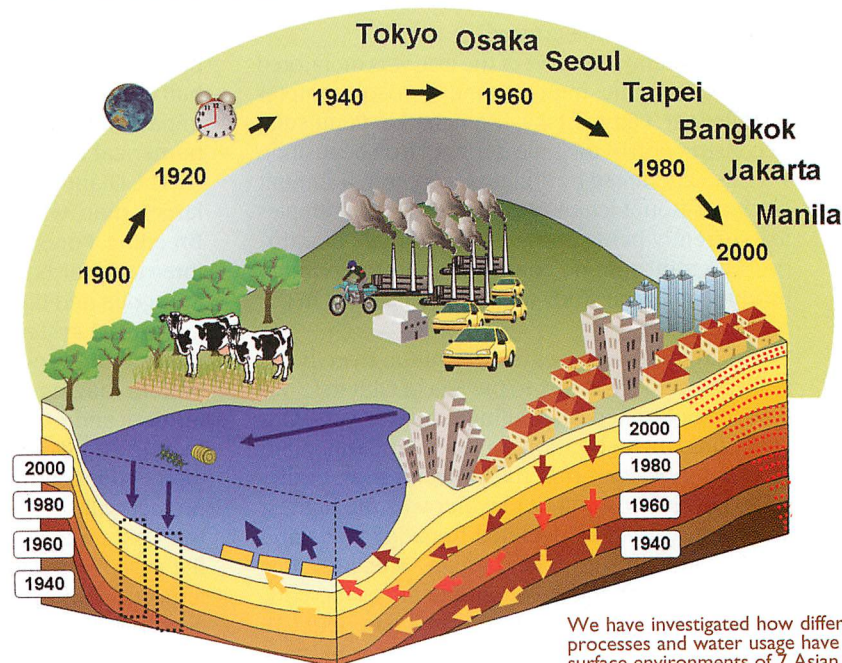
Objectives of this Project

Most global environmental studies have long been focused on the environmental issues above ground such as air pollution, global warming, sea-water 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 and 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.

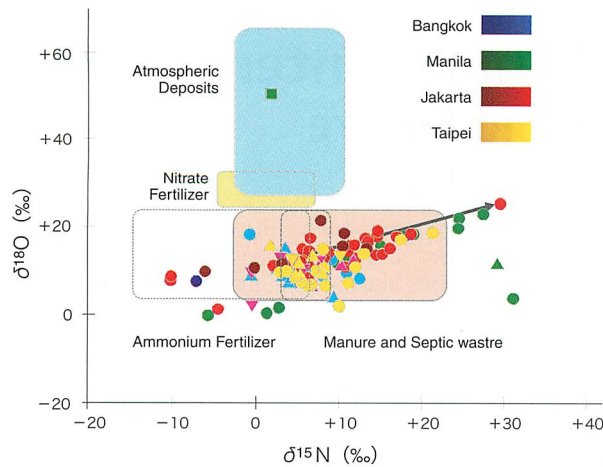
This project deals with: (1) Relationships between the development stages of cities and subsurface environmental problems which will be assessed by socio-economic analyses and reconstructions of urban areas using historical records; (2) Serious problems in subsurface environment and changes in reliable water resources which will be studied after evaluation of groundwater flow

Figure 1 Schematic Model of this Project



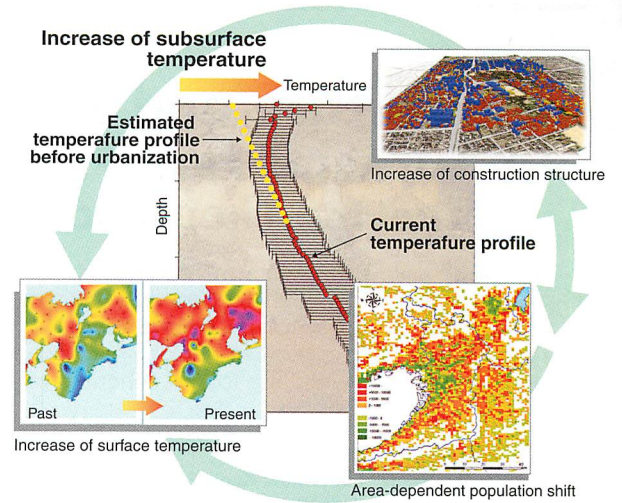
We have investigated how different development processes and water usage have affected the subsurface environments of 7 Asian megacities.

Figure 2 Distribution of Nitrate N and O Isotopes in Groundwater at Each Asian Megacity



The sources of nitrate pollution and their pathways have been investigated using stable isotope signatures and various statistical data.

Figure 3 Model of Collaboration Studies



Increases of construction and energy consumption associated with population increase brought surface temperature increases. The historical change of surface temperature is recorded as a profile of subsurface temperature.

Photo 1 Children Drawing well Water in Manila



Why don't we save valuable water resources for children in the future?

water flow systems and changes in groundwater storage using hydrogeochemical data and in-situ/satellite-GRACE gravity data; (3) Evaluation of accumulation of materials (contaminants) in the subsurface and their transport from land to ocean, including groundwater pathways using chemical analyses of subsurface water, sediments and tracers; and (4) Evaluation of subsurface thermal contamination due to the "heat island" effect in urban areas by reconstruction of surface temperature history and urban meteorological analyses.

Progress of the Project

- Field surveys on the subsurface environment in targeted cities have been made (6 times in 2005 and 9 times in 2006), and monitoring of subsurface environments has started.
- Assessments of natural and social data in each city have been made, and the structure of the project database based on GIS has been made for future work.

- Preliminary models such as GRACE, groundwater flow, and DPSIR have been established in each sub theme.
- In order to evaluate the origin and process of material loads to the subsurface, isotopes and chemical analyses of water samples have been made, and new tracers (CFC, Kr etc.) techniques have been introduced.
- Subsurface thermal signals can be used to reconstruct the history of urbanization.

- The International Symposium on "Human Impacts on Urban Subsurface Environment" was held, and the proceedings were published. Co-operation with international research agencies (UNESCO- GRAPHIC, GWSP-Asia etc.) has begun.

Future Work and Challenges

- The 2nd international workshop will be held in Indonesia in December 2007 to evaluate the interim results and find additional themes and problems in the project.
- In order to present the interim results of the project, a special issue of STOTEN (Science of Total Environment, Elsevier) will be prepared.
- New approaches to the relationship between groundwater and religion will be launched.
- A new observation system using CFC, Kr and absolute gravity measurement will be tested, and cross-comparison with different observation methods will be undertaken.