

# Human Impacts on Urban Subsurface Environments

This project assesses the effect of human activities on urban subsurface environments, an important but largely unexamined field of human-environmental interactions. Subsurface conditions merit particular attention in Asian coastal cities where population numbers, urban density and use of subsurface environments have expanded rapidly. The primary goals of this project are to evaluate the relationships between urban development and subsurface environmental problems such as extreme subsidence, groundwater contamination, and thermal anomalies associated with the urban "heat island" effect, and to provide recommendations of how these impacts can be addressed or voided in the seven Asian coastal cities under study.



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## Project objectives

Most global environmental studies have focused on above ground environments. Subsurface environments, though they are involved in biogeochemical circulations and are critical to overall environmental quality, have been largely ignored, perhaps because of their invisibility and difficulty of evaluation. Subsurface environmental problems such as subsidence and groundwater contamination are repeatedly manifest in major Asian cities, though there is often a time lag between the "stage" of urban development and recognition of subsurface impacts. It may be possible to assess and improve future urban environments through understanding of urban

areas' historical impact on surface environments. This project investigates subsurface environmental conditions in Tokyo, Osaka, Bangkok, Jakarta, Seoul, Taipei and Manila. The relationships between these cities' historical development and their impact on subsurface environments will be assessed by socio-economical analyses and historical records. Hydrogeochemical and in-situ/satellite-GRACE gravity data will describe groundwater flow systems and changes in groundwater

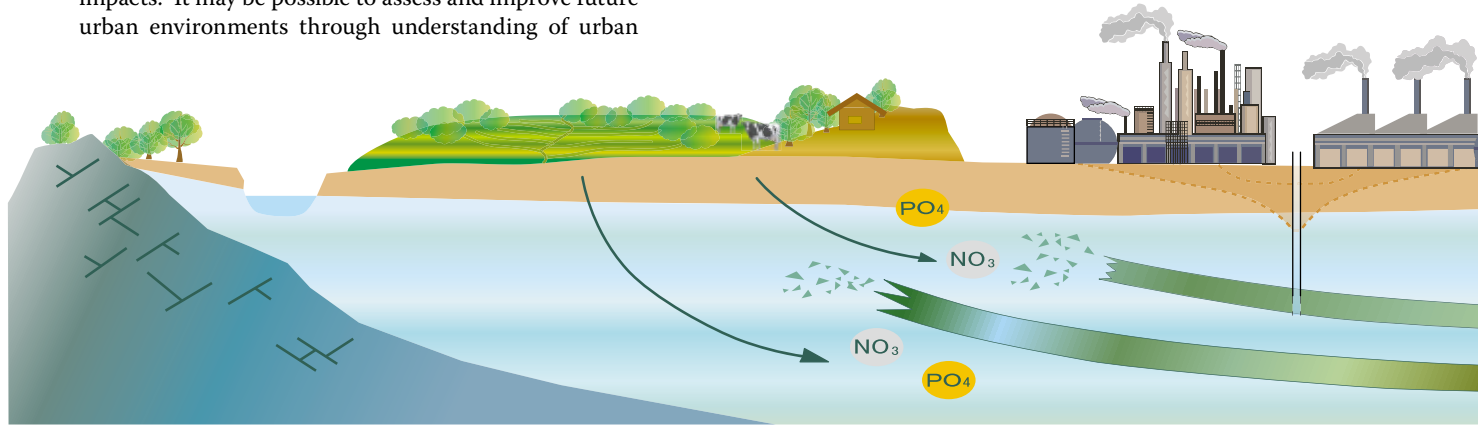


Figure 1 Research Structure

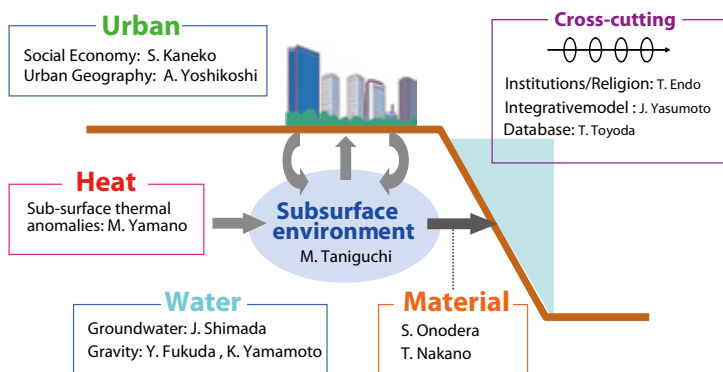
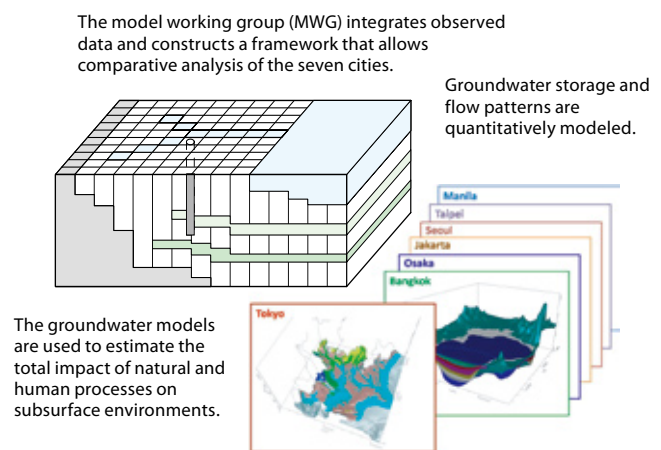
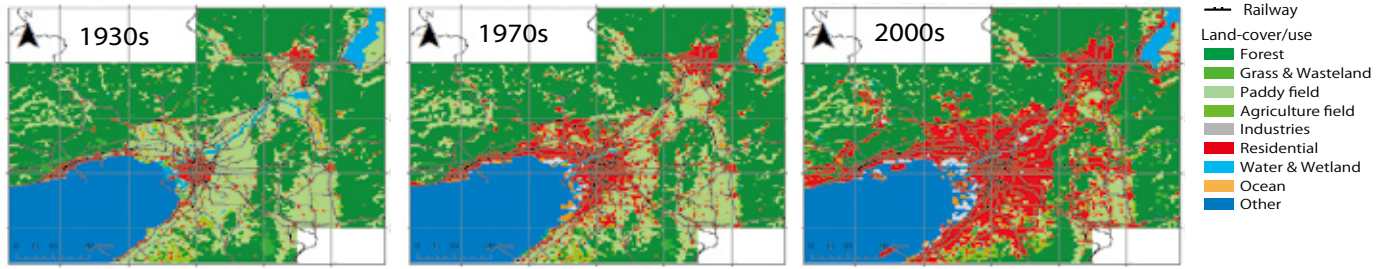


Figure 2 Cross-cutting analysis: Integrated models



**Figure 3 Cross-cutting analysis : GIS working group**



Changes in land use/cover in Osaka. Residential areas have expanded along the railway corridors.

storage, and indicate where significant problems in subsurface environments exist. Chemical analyses of subsurface waters, sediments and tracers will allow us to evaluate contaminant accumulation and their transport from land to ocean. Finally, we will use urban meteorological analyses to reconstruct surface temperature histories in the seven cities and to examine the impact of the urban “heat island” effect on subsurface thermal contamination.

**Progress in 2008**

Subsurface environment in targeted cities have been surveyed, and monitoring of subsurface environments in Bangkok, Jakarta, Manila, Seoul, Taipei, Tokyo and Osaka is ongoing.

Natural and social data have been assessed in each city, and compiled into a GIS database. Based on this data, land use/cover maps of 0.5 km mesh were composed for each city at three development stages (1930s, 1970s, and 2000s)

RIHN project members co-organized the interna-

tional symposium, *HydroChange2008*, based on which the book “*From Headwater to the Ocean*” was published by CRC press (2008).

Several cross-cutting themes, such as the relation between groundwater and religious sites and beliefs in Bangkok and Jakarta, have been identified and investigated.

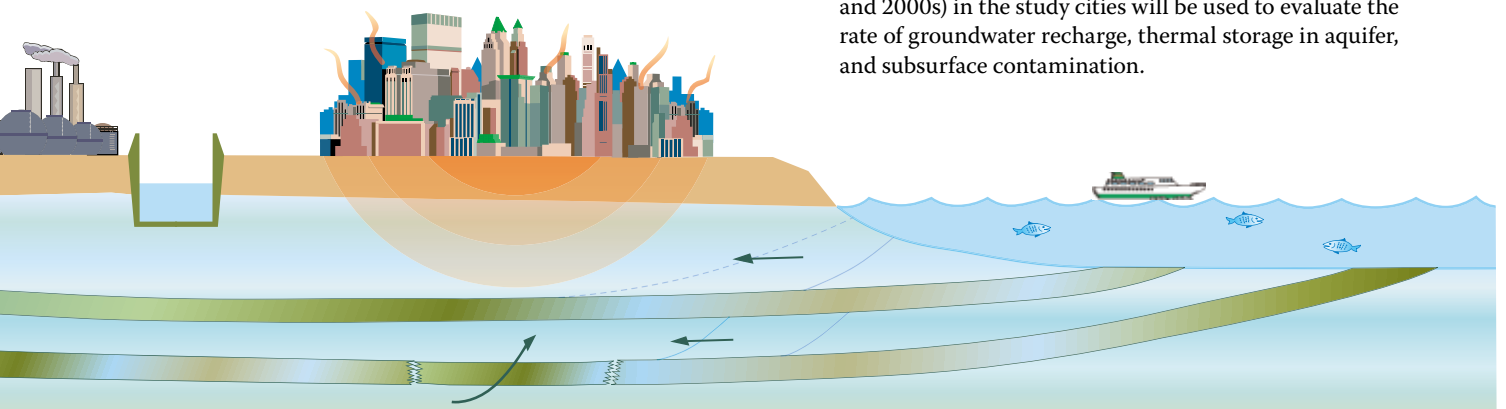
Interim results of the project were published as a special issue of the journal *Science of the Total Environment* (STOTEN vol. 407[9], 2009), which included an overview of the project and 15 original papers.

**Future works and challenges**

Analysis of water use and quality in relation to public/private water rights and the distinct regulatory histories of surface and groundwater in the various cities.

The Model Working Group has been formed in order to integrate the impacts of economics, water resources, environmental loads, and policy on subsurface environments.

Land use/cover data taken at three dates (1930s, 1970s and 2000s) in the study cities will be used to evaluate the rate of groundwater recharge, thermal storage in aquifer, and subsurface contamination.



**Figure 4 Cross-cutting themes: Legal institutions**

This figure demonstrates that appropriate regulation and balanced use of surface- and ground-water can reduce inefficient use. In both Osaka and Bangkok, facilitating access to abundant surface water reduced use of groundwater.

