

Human impacts on urban subsurface environment

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Securing water resources and cleaning contaminated water caused by human activities in urban areas are global environmental issues for the 21st century. Heat island phenomena created by human activities is also a significant environmental problem in addition to global warming. These global environmental issues which are caused by urbanization, should be addressed seriously 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 in the present and future, but have been largely ignored because of the invisibility of the phenomena and difficulty of the evaluations.

Transformations of water resources between groundwater and surface water occurred in many Asian cities depending on the development stage of urbanization. Although surface water is relatively easy to evaluate, changes in regional groundwater storage remain a difficult task. Recent new techniques using Satellite GRACE (Gravity Recovery and Climate Experiment) and isotope data to evaluate groundwater flow systems may be able to evaluate the regional scale of groundwater issues.

Regarding material (contaminant) transport to the coast, direct groundwater discharge is recently recognized as a significant water and material pathway from land to ocean. Many Asian major cities are located in the coastal zone so material and contaminant transport by groundwater is a key to understanding the coastal water pollution and the effects on associated ecosystems. Previous studies have showed some relationships between direct groundwater discharge and coastal ecological problems such as harmful algal blooms.

Recent global warming is considered a global environmental issue only above the ground. However, subsurface temperatures are also affected. In addition, the heat island effect due to urbanization creates subsurface thermal contamination in many cities. The combined effects of heat island and global warming reaches up to more than 100 meters below the surface, and the increased rate of subsurface temperature in cities by the heat island effect is much larger than that of global warming.

Subsurface environmental problems such as subsidence due to excessive pumping, groundwater contaminations, 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.

In this presentation, a new project of RIHN will be introduced, and some preliminary results will be shown. This project will assess the effects of human activities on the 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 increase and concentration occurs rapidly, and uses of subsurface environment have increased. The primary goal of this project is to evaluate the relationships between developmental stage of cities and various subsurface environmental problems, as extreme subsidence, groundwater contamination, and subsurface thermal anomalies. We will focus on (1) relationship between socio-economic stage of the cities and subsurface environmental problems, (2) disasters in subsurface environments and transformation of water resources, (3) evaluations of accumulations of materials (contaminants) in subsurface and their transports from land to ocean, and (4) subsurface thermal contamination due to the heat island effect in urban areas. Finally, we will address the sustainable use of groundwater and subsurface environments for better future development for human well-being.