Degradation of subsurface environment in Asian coastal cities

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Subsurface environmental problems such as subsidence due to excessive pumping, groundwater contamination, and subsurface thermal anomalies have occurred repeatedly in Asian major cities with a time lag depending on the development stage of urbanization. Recent new techniques using remote gravity measurement and isotope data to evaluate groundwater flow systems may be able to evaluate the regional scale of groundwater issues in urban area. 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. 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. The purposes of this study are to evaluate the changes in groundwater storage which caused subsidence in each Asian city, and potential groundwater recharge rate, to evaluate accumulations of materials (contaminants) in subsurface and their transports from land to ocean, and to evaluate subsurface thermal contamination due to the heat island effect in urban areas. The subsurface temperature observed in study cities show the surface warmings due to global warming and heat island effects during the last 100 years are 2.8, 2.5, 2.2, 1.8, 1.2 degree celcious in Tokyo, Seoul, Osaka, Bangkok, and Jakarta, respectively. The depth apart from the thermal gradient depends on the magnitude of surface warming and the time starting from surface warming. The observed depths apart from the thermal gradient were in order of Tokyo, Osaka, Seoul, Bangkok, and Jakarta. Therefore the analyses using those depths may show the development stage of the cities.