

HSC016-02

Room: 101

Time: May 23 09:15-09:30

Sustainable use and futurability of subsurface environment in Asian coastal cities

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Land subsidence due to excessive groundwater pumping, groundwater contamination, and subsurface thermal anomaly have been repeatedly occurred in Asian coastal cities. The relationship between development stage of the city and subsurface environment problems have been analyzed with both integrated indices of changing society and environment, and natural capacity. Integrated indices, such as population and income (Driving force), groundwater pumping and dependency (Pressure), groundwater level (State), land subsidence (Impact), and regulation of pumping (Response), have been made on a yearly basis for seven cities over 100 years (1900-2000). Five development stages of the city are recognized in Tokyo based on the DPSIR, and six other cities are compared with Tokyo for (1) land subsidence, (2) groundwater contamination, and (3) subsurface thermal anomaly. Groundwater storage and groundwater recharge rate in seven cities have been compiled as integrated indices for natural capacities of changing climate and society. A five-stage model and a DPSIR model revealed that Bangkok had the following benefit (relatively small damage with same driving force/pressure), Taipei had a higher natural capacity (higher groundwater recharge rate), and Jakarta had excessive development compared to Tokyo for land subsidence issue. GIS data base of land cover/use changes in seven cities have been made for three different periods (1930s, 1970s, and 2000s) for Tokyo, Osaka, Seoul, Taipei, Bangkok, Jakarta, and Manila with 0.5 km grid using 9 different land cover/use types. By making comparisons to natural capacities (groundwater storage, groundwater recharge rates, etc) and changing society and environment indicators via the DPSIR model, we can see that Asian coastal areas have a positive potential for groundwater recharge. It is thus possible to manage the groundwater resources in a sustainable fashion in this region.

Keywords: urbanization, subsurface environment, GIS, Asian coastal city