Effects of global warming and heat island on subsurface environment in Asia
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Abstract

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 both effects of global warming and heat island on subsurface temperature in Asian cities. Subsurface temperature observed in the study areas showed the surface warming during the last 100 years were 2.8, 2.5, 2.2, 1.8, 1.2 degree Celsius in Tokyo, Seoul, Osaka, Bangkok, and Jakarta, respectively. Comparisons between analytical solutions and observations show that the mean depth of deviation from the regional geothermal gradient in each urban area may be one of the indicators of the history of urbanization in each city. The mean depth of deviation from the steady thermal gradient, which is approximately 140 m in Tokyo, 80 m in Osaka, and 50 m in Seoul and Bangkok, indicates the time from the start of the additional heat from urbanization. These results agreed qualitatively with air temperature records in the cities during the last 100 years. The heat island effect on subsurface temperature is an important global groundwater quality issue, because it may alter the groundwater systems chemically and microbiologically. Measurement of subsurface temperature data provides important information for understanding the joint effects of urbanization and global warming on groundwater systems.