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Some aspects of groundwater flow conservation methods in underground construction works in urban areas

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Japan, as an earthquake-prone country in one of the world's most active seismic areas, faces severe damages on its infrastructure every year. The necessity to reconstruct old and build new railroads and motorways is emerging. Limited space for new constructions led to a stronger focus on underground tunnels, particularly in densely populated areas. While underground tunnels free cities from traffic above ground, they inhibit natural water flow and can have negative effects on surrounding structures and the environment, especially in shallow and soft grounds. Without adequate measures for groundwater flow conservation, rising groundwater levels upstream of the underground tunnel increase the buoyancy forces on the underground structure, the risk of liquefaction of sandy soils during earthquakes, as well as the leakage flow into the structure. The quality of the stagnating groundwater deteriorates and the saturation of the root zone adversely effects plant growth. On the other hand, falling water levels downstream potentially lead to ground subsidence and building lean, as well as the depletion of ponds, small streams, paddy fields, and the root zone in general. Moreover, the soil's redox conditions change from anoxic to oxic, thus, deteriorating groundwater quality due to the mobilization of ions, or heavy metals in polluted areas. Further, in coastal areas, also salt water intrusion has to be considered.
Measures to preserve the natural groundwater flow come with challenges in design and application. Design and installation of collection and recharge wells have to consider not only the correct distance between the wells. Especially practicable methods for long-term diagnostics and maintenance of the wells have to be established in order to prevent and treat deterioration and clogging.