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Barrier effect of underground structures on aquifers

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The growth of population and cities demands the construction of underground structures. It is essential to consider not only the construction stage but also the long term effects of these structures on the aquifer. Impervious structures below the water table modify the natural flow of aquifers. They cause the head to rise upgradient and to fall downgradient. We define the barrier effect as the increase in head loss across the barrier with respect to the natural conditions prior to construction. The barrier effect causes negative environmental and economic impacts such as flood basements, soil salinization, seawater intrusion and drying of wells. We distinguish between regional (the minimum head loss observed at long distances) and local (the maximum head loss observed close to the structure) barrier effects. We use numerical and analytical methods to derive semi-empirical equations to quantify the two barrier effects for different types of barriers. To protect groundwater resources, these equations should be used as a management tool to predict and to minimize the impact caused by underground structures prior the construction. The resulting equations depend on the barrier geometry and on the natural head gradient in the aquifer and are easy to apply. We tested their validity at two construction sites, where a barrier effect was measured, obtaining excellent agreement between the computed and the observed barrier effects.