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Towards a global land subsidence map

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Human activities have intensified large and growing global groundwater depletion problems. Groundwater depletion under cities in delta regions or river valleys is in many cases leading to significant land subsidence, causing damage to infrastructure and increases in the risk of flooding. Yet, a global land subsidence map is not available. Such map is crucial to raise global awareness of land subsidence. Land subsidence is costly (probably in the order of billions of dollars annually). One of the most prominent causes for land subsidence is excessive groundwater extraction for domestic, agricultural and industrial use. For instance, the Vietnamese Mekong Delta sinks on average 1.6 cm/yr, attributed to groundwater extraction. Crucially, in many coastal mega-cities, land subsidence is accelerated by ongoing urbanization. In Jakarta land subsidence is up to 20 cm/yr. With ongoing economic development and related increased demands for water, the expectation is that land subsidence rates and areas affected will accelerate and expand in the near future. A global land subsidence map would not only locate current land subsidence hotspots but also help to identify future sinking areas under different socio-economic development scenarios.
A global hydrological model, PCR-GLOBWB, serves as the starting point. The hydrological model includes a global simulation of spatio-temporal groundwater head dynamics under abstractions for the period 1960-2100. The hydrological model is coupled to a land subsidence module, iMOD-SUB-CR, which is an extension of the MOD-FLOW SUB-WT module developed by the USGS. The required subsurface information is unavailable at this time, but will be approached by using different scenarios of subsurface build-up. The outcomes will be compared to measured or modeled land level lowering in well-known damaging case study areas, such as Jakarta and the Vietnamese Mekong Delta, as well as in well-known recovering areas, such as Venice and Tokyo, which have managed to stop land subsidence problems by ceasing groundwater abstraction.
The final map will include also future land subsidence rates under different development scenarios for the entire earth, and includes a sensitivity test for different subsurface build-up. The entire map will be used as input for a global flood risk model. Moreover, with the global land subsidence map relative sea level rise predictions may be improved as well.