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A future geodetic monitoring system for vertical land motion in the Perth basin, Australia

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Vertical land movement (VLM) affects many regions around the world and can have various causes, such as tectonics, glacial isostatic adjustment and resource extraction. Geodetic monitoring systems are employed in different configurations to identify VLM to provide knowledge for hazard mapping, risk assessment and land planning. We describe results from historical geodetic observations, and efforts to establish a monitoring system in the Western Australian city of Perth, which is subject to VLM, most probably caused by groundwater extraction over the past $\sim$100 years. The most direct evidence of VLM in Perth is provided by two continuously operating GNSS (CGNSS) stations HIL1 (from 1997) and PERT (from 1992). However, these stations provide estimates only at discrete locations. In addition, the data from HIL1 is subject to frequent equipment changes and PERT ceased operation in early 2012. The CGNSS VLM rates reach $\sim$-6 mm/yr, but are not linear over time and appear to be highly correlated with the rates of groundwater extraction. Limited sequences of interferometric synthetic aperture radar (InSAR) images are available over short periods between 1992-2009, and although these suggest spatially variable VLM rates reaching -5 mm/yr at some locations, the uncertainty from the small number of images suggest that these results should be treated cautiously. If it remains necessary to extract groundwater for Perth (possibly at increased rates), an ongoing monitoring programme is needed. This should be based on combined GNSS, InSAR and levelling observation programmes. Historical levelling data from the early 1970s is currently being extracted from hardcopy archives into digital file format for analysis and adjustment. These data will be used to establish an original reference network for later geodetic observations comprising repeat levelling campaigns connected to periodic GNSS campaigns and CGNSS stations, but most importantly, a regular and structured acquisition of InSAR imagery. The InSAR component is necessary to avoid reliance on discrete monitoring stations and to provide larger scale mapping of the subsidence. As the framework for an ongoing monitoring programme, images are being acquired from the German Aerospace Centre's (DLR's) TerraSAR-X satellite mission under a collaborative science project among Geoscience Australia, Curtin University of Technology, Landgate and Karlsruhe Institute of Technology. This programme initially covers $\sim$13 months (up to 30 images) and will provide sufficient data to lay the foundation for ongoing monitoring. This monitoring programme will be used to determine linear and non-linear VLM in Perth at time scales ranging from seasonal to long term over multiple years.