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Geological weighing lysimeters for accurate undisturbed monitoring of ground surface water budgets in real time

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Geological weighing lysimeters (gwl) offer a hectare-scale approach for disturbance-free monitoring of water storage changes at the land surface. This novel hydrological technique is still largely unknown but a demonstration site in New Zealand has been operating successfully for a number of years. The method utilises accurate monitoring of static pore water pressures in fully-confined deep aquifers with no hydraulic connection to the land surface of interest above. The aquifer pore water serves as a weighing fluid which experiences pressure changes in response to aquifer elastic deformation from ground surface loading, allowing area-integrated water storage changes to be monitored in real time by way of the aquifer loading coefficient. Coupling gwl observations with independent surface recording yields further information. In particular, subtracting recorded surface evaporation from gwl storage time series yields a time series of site net lateral groundwater flux, the gradient of which corresponds to site groundwater specific discharge. These quantities would be almost impossible to obtain by standard hydrological instrumentation. Replication of observations using independent confined aquifers (vertically separated) guarantees freedom from dynamic noise such as recharge effects. Combining replicated results can yield length-dimension storage values with accuracy comparable to a rain gauge. Some results of gwl monitoring are presented for the New Zealand site, which is set in pasture grassland. The technique has considerable potential for monitoring area-integrated water storage changes in many surface environments, including tropical rainforests, wetlands, polar environments, and arid regions where conventional water budget estimates may be difficult

in the absence of stream discharges. As a move toward acceptance of gwl's as a new hydrological tool, a call is made for a joint international initiative to establish gwls around the world and report back on collective experience and information gained.