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Forecasting and Predicting Coastal Local Sea Level as Support for Coastal Zone Management Decisions and Policy Making (*Invited*)

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Local Sea Level (LSL) rise is one of the major anticipated impacts of future global warming with potentially devastating consequences, particularly in many low-lying, often subsiding, and densely populated coastal areas. Risk and vulnerability assessments in support of informed decisions ask for predictions of the plausible range of future LSL trajectories as input, while mitigation and adaptation to potentially rapid LSL changes would benefit from a forecasting of LSL changes on decadal time scales. Low-frequency to secular changes in LSL are the result of a number of location-dependent processes including ocean temperature and salinity changes, ocean and atmospheric circulation changes, mass exchange of the oceans with other reservoirs in the water cycle, and vertical land motion. Mass exchange between oceans and the ice sheets, glaciers, and land water storage has the potential to change coastal LSL in many geographical regions. LSL changes in response to mass exchange with land-based ice sheets, glaciers and water storage are spatially variable due to vertical land motion induced by the shifting loads and gravitational effects resulting from both the relocation of surface water mass and the deformation of the solid Earth under the load. As a consequence, close to a melting ice mass LSL will fall significantly and far away increase more than the global average. The so-called sea level equation expresses LSL as a function of current and past mass changes in ice sheets, glaciers, land water storage, and the resulting mass redistribution in the oceans. Predictions of mass-induced LSL changes exhibit significant inter-model differences, which introduce a large uncertainty in the prediction of LSL variations caused by changes in ice sheets, glaciers, and land water storage. Together with uncertainties in other contributions, this uncertainty produces a large range of plausible future LSL trajectories, which hampers the development of reasonable adaptation strategies for the coastal zone. While the sea level equation has been tested extensively in postglacial rebound studies for the viscous (post-mass change) contribution, a thorough validation of the elastic (co-mass change) contribution has yet to be done. Accurate observations of concurrent LSL changes, vertical land motion, and gravity changes required for such a test were missing until very recently. For the validation, new observations of LSL changes, vertical land motion, and gravity changes close to rapidly changing ice sheets and glaciers in Greenland, Svalbard, and other regions, as well as satellite altimetry observations of sea surface height changes and satellite gravity mission observations of mass changes in the hydrosphere are now available. With a validated solution, we will be able to better characterize LSL changes due to mass exchange of the oceans with, in particular, ice sheets and glaciers as an important contribution to the plausible range of future LSL trajectories in coastal zones. The current "error budget" will be assessed, and the impact of the uncertainties in LSL forecasts (on decadal time scales) and long-term projections (century time scales) on adaptation and mitigation strategies will be discussed.

http://geodesy.unr.edu/hanspeterplag/sealevel

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