Geophysical Research Abstracts,
Vol. 11, EGU2009-11060, 2009
EGU General Assembly 2009

How to reduce the uncertainties in predictions of local coastal sea level as decision support: the contribution of GGOS

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Local Sea Level (LSL) rise is one of the major anticipated impacts of future global warming. In many low-lying and often subsiding coastal areas, an increase of local sea-surface height is likely to increase the hazards of storm surges and hurricances and to lead to major inundation. Single major disasters due to storm surges and hurricanes hitting densely populated urban areas are estimated to inflict losses in excess of $100 billion. Decision makers face a trade-off between imposing the very high costs of coastal protection, mitigation and adaptation upon today's national economies and leaving the costs of potential major disasters to future generations. Risk and vulnerability assessments in support of informed decisions require as input predictions of the range of future LSL rise with reliable estimates of uncertainties. Secular changes in LSL are the result of a mix of location-dependent factors including ocean temperature and salinity changes, ocean and atmospheric circulation changes, mass exchange of the ocean with terrestrial water storage and the cryosphere, and vertical land motion. Current aleatory uncertainties in observations relevant to past and current LSL changes combined with epistemic uncertainties in some of the forcing functions for LSL changes produce a large range of plausible future LSL trajectories. This large range hampers the development of reasonable mitigation and adaptation strategies in the coastal zone.

A detailed analysis of the uncertainties helps to answer the question what and how observations could help to reduce the uncertainties. The analysis shows that the Global Geodetic Observing System (GGOS) provides valuable observations and products towards this goal. Observations of the large ice sheets can improve the constraints on the current mass balance of the cryosphere and support cryosphere model validation. Vertical land motion close to melting ice sheets are highly relevant in the validation of models for the elastic response of the Earth to glacial deloading. Combination of satellite gravity mission with ground-based observations of gravity and vertical land motion in areas with significant mass changes (both in cryosphere, land water storage, and ocean) could help to improve models of the global water and energy cycle, which ultimately improves the understanding of current LSL changes. For LSL projections, local vertical land motion given in a reference frame tied to the center of mass is an important input, which currently contributes significantly to the error budget of LSL predictions. Improvements of the terrestrial reference frame would reduce this error contribution.