Study of long term data sets – overview of results

Long term data sets of water level data for Norway was studied in the Norwegian report on sea level changes published in 2015. This document includes

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Report details:

Sea Level Change for Norway
Past and Present Observations and Projections to 2100

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Abstract:

Changes to mean sea level and/or sea level extremes (e.g., storm surges) will lead to changes in coastal impacts. These changes represent a changing exposure or risk to our society. Here we try to synthesize our understanding of past and present observed sea level changes for Norway, as well as providing sea level projections up until 2100. Our primary focus is changes to mean sea level but we also give updated return heights for each coastal municipality in Norway.

We first analyse observed sea level changes from the Norwegian tide gauge network and from satellite altimetry. After the tide gauge data have been corrected for the effects of glacial isostatic adjustment, we show that 20th century sea level rise in Norwegian waters is broadly similar to the global average rise. Contributions to the observed sea level change and variability are discussed. We find that rate of sea level rise along the Norwegian coast is significantly higher for the period 1993–2014 than for the period 1960–2010. It is unclear, however, to what extent this higher rate represents natural variability rather than a sustained increase owing to global warming.

Our regional sea level projections are based on findings from the Fifth Assessment Report (AR5) of the Intergovernmental Panel for Climate Change (IPCC), and the Coupled Model Intercomparison Project phase 5 (CMIP5) output. Average projected 21st century relative sea level change in Norway is -0.10–0.35 m (5 to 95% model ranges which is the *likely* range in AR5; P>66%) for RCP2.6, -0.05– 0.45 m for RCP4.5, and 0.10–0.65 m for RCP8.5. The relative sea level projections can differ as much as 0.50 m from place to place. This pattern is governed by the vertical uplift rates. Quantifying the probability of levels above the *likely* range (i.e., the upper tail of the probability distribution) remains difficult because information is lacking. And of particular concern is that the ice sheet contribution might have a skewed distribution, which would mean values in its upper tail would be quite large.

Finally, we show how the estimated return heights can be combined with our regional sea level projections to provide allowances. Allowances give the height by which an asset needs to be raised so that the probability of flooding remains preserved for a given sea level change. A possible attractive option in planning.

Summary of chapter 3: OBSERVED SEA LEVEL CHANGES IN NORWAY

3.5 Chapter Summary

The relative sea level rates for the periods 1960 to 2010 and 1984 to 2014 estimated from the Norwegian tide gauge network reflect the pattern of land uplift. A fall in relative sea level is observed in Oslofjorden and in the middle of Norway, while a rise is observed along the southern and western coast of Norway and for the northernmost tide gauges. After correcting the rates for glacial isostatic adjustment (GIA), the resulting sea surface height rates are positive at all tide gauges. The coastal average is 1.9 and 2.4 mm, respectively, for the first and latter period. These are close to the global average rates for the 20th century, which also showed an increase towards the end of the century. It should be noticed that the GIAcorrected rates for an unknown reason vary considerably between the sites. However, the vertical motion of the tide gauges are in general weakly constrained.

Over the more recent period 1993–2014, the average rate of coastal sea level rise south of 66°N is estimated from two satellite altimetry datasets as 3.4 ± 0.7 mm/yr (TOPEX/POSEIDON, Jason) and as 3.1 ± 0.7 mm/yr (ERS, ENVISAT). And these numbers agree well with the rate obtained from the tide gauge network (3.8 ± 0.6 mm/yr). The rate of sea surface rise along the Norwegian coast is significantly higher for the period 1993–2014 than for the period 1960–2010. It is unclear, however, to what extent this higher rate represents natural variability rather than a sustained increase owing to global warming.

There are not enough observations available to assess all contributions to the sea level trends at the Norwegian coast. The observed changes point to warming ocean and melting land ice to be the most prominent contributors to observed sea level trends for the Norwegian coastline, as they are for the global mean. For the period 1960 to 2010, hydrographic observations show that thermal expansion contributed between 0.5 and 1 mm/yr to the trends in sea surface height while the contributions from measured change in salinity and atmospheric pressure are less than ± 0.5 mm/yr. Estimates of the regional contribution from mass input to the ocean vary between 0.5 and 0.9 mm/yr over similar periods.

The observed regional sea level trends can provide some guidance on what to expect in the near future. However, it is important to be aware that the estimated RSL rates are extremely sensitive to the selected study period, which is indicative of strong interannual to multidecadal variability in the tide gauge records. Any extrapolation should therefore be done with caution.