

Analyzing regional sea level changes: Tidal characteristics, intra- and inter-annual frequencies, probabilistic trends

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Keywords Tidal characteristics · probabilistic trends

During the 20th century a significant rise in global and also regional mean sea level is estimated by various studies and different authors using several techniques. However, the rates of the rise vary across the globe. There are even regions of increase and regions of decrease. Furthermore, in tidal dominated regions the “mean” sea level (MSL) allows only inaccurate disclosures about possible changes. In measures for the management of coastal waterways also the tidal characteristics have to be taken into account. In the German Bight the mean tidal high water levels (MHW) and the mean tidal low water levels (MLW) underlie a significant historic trend, which is different for these two and also differs to the trend of the MSL. This implies a change of the tidal ranges. Beside these three parameters also the characteristics of the durations of the tidal cycle are investigated with two more parameters: the flood period and the ebb period.

First, this current study investigates the frequency spectrum by the means of the Lomb-Scargle Periodogramm for eight representative tide gauges in the German Bight. To analyze the results the main periods on intra- and inter-annual frequencies of the tidal characteristics are detected and ranked. Both, the spring to neaps cycle and the 14 day diurnal tidal cycle dominate the intra-annual signal and results in a fluctuation of tides through the months of the year. Tides only completely repeat themselves every 18.6 years which is the Nodal cycle, forced by the periodical change of the angle between the lunar ecliptic and the equator ecliptic. This is generally the most important inter-annual cycle for MLW and often also for the tidal range. For other tidal characteristics several other periodicals conceal the signal of the nodal cycle. Some lengths are in order of 30 to 40 years, which might indicate the strong relation to the atmospheric forcing in this region. On the other hand, the length of the time series always has to be considered interpreting the results.

To get a probabilistic trend yearly probability density functions (PDF) of each tidal characteristic are estimated. The PDF can be used to calculate the yearly mode of the time series, which excludes the extreme values in the trend. Therefore this method is more robust than the commonly used simple arithmetic mean. A spatial variable increase of the tidal range in the range between 1.5 mm / year and 6 mm / year (excluding one tide gauge with almost no changes) indicate a complex change of the tidal constitutes in the German Bight during the last 44 up to 110 years, depending on the length of the time series. The conclusion can be drawn that changes in the MSL alone are not suited as parameter to derive strategies of adaptation of coastal waterways in the German Bight. Against that changes of tidal characteristics as a whole must be considered.