Geophysical Research Abstracts
Vol. 19, EGU2017-1837, 2017
EGU General Assembly 2017

Barrier island groundwater salinity and vegetation influenced by storm tides and inundation frequency

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Coastal ecosystems are characterized by the interrelation of ground surface elevation, sea level, inundation frequency, shallow groundwater salinity and vegetation. The understanding of this correlation is not only necessary with respect to coastal ecosystem functioning but also of major interest for drinking water supply. Conducted pore water sampling, analysis of water level data and measurements of ground surface elevations enabled an integrated analysis of these parameters at a presently developing highly dynamic barrier island in the North Sea largely unaffected by humans. The results of this study are particularly relevant in view of predicted rising sea-level and increasing storm-water frequencies and show the pronounced influence of storm tides and inundation frequency on shallow groundwater salinity at the eastern part of the barrier island Spiekeroog, the so-called 'Ostplate', at the Northwest German Coast. The shallow freshwater reservoir is only to be found below the elevated dune areas whereby its extent is determined by storm tides and shows spatial and seasonal variations, depending on the time passed since the last storm tide. The inundation frequency influences the shallow groundwater salinities and both are largely a function of ground surface elevation. Brackish groundwater is present in the shallow subsurface if flooded more than once in the year prior to sampling. The dependence of shallow groundwater salinity on the ground surface level can be quantified with an exponential function. Combining this function with digital elevation models enabled to infer on past and present shallow groundwater salinity distributions within the study area. As a consequence of generally rising ground levels in a morphodynamically highly active environment, decreasing salinities could be detected. Since the inundation frequency also affects the vegetation zonation, an identified match between shallow groundwater salinities and zonation of vegetation suggests that groundwater salinities may be inferred from vegetation maps.