Interactions between tidal inundation and sediment accretion in a marsh with controlled reduced tide

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All over the world tidal marshes are disappearing because of submergence, which is the result of global sea-level rise and local marsh surface sinking at the same time. Local variations in mean high water level (MHWL) change and marsh sinking rate determine the potential for submergence. Therefore site-specific information is needed to unravel the main determining processes and hence develop appropriate management strategies for each tidal wetland.

Along the Scheldt Estuary (Belgium/Netherlands) some tidal marshes are being restored using controlled reduced tide (CRT). In the CRT-area high inlet culverts and low outlet valves allow a reduced tidal regime to enter the former agricultural polder, the tide in the polder is a copy of the tide that floods the natural habitats at the other side of the dike.

In natural tidal marshes spatial and temporal variations in sedimentation are a result of the position in the tidal frame in combination with e.g. distance to creeks. An inundation-elevation change (△E) feedback is typical for a natural tidal marsh (i.e. rising marsh elevation results in decreasing inundation depth and therefore a decreasing increase of elevation). In the CRT area sluice dimensions determine the amount of water flooding the area, not position in the tidal frame, and it is expected that the inundation-△E feedback is absent. Consequently, the CRT MHWL follows the increase of CRT surface elevation.

Long term elevation change and sediment accretion rates were measured since the start, March 2006, with high frequency in the newly created area Lippenbroek as well as natural marshes. Continuous tidal measurements were performed in the Scheldt and in Lippenbroek and MHWLs per spring-neap cycle were calculated between March 2006 and March 2014.

Initially a strong increase of elevation of the lowest elevated sites followed by a progressive decrease. In the last 4 years the intermediate sites started to increase faster than in the first 4 years. Also initially elevated sites show a higher △E rate between 2010 and 2014. MHWLs in the Lippenbroek increase over 8 years with 13cm while MHWLs in the Scheldt don't show any change. This means that the total area is silting up with 1.6cm per year causing the increase of MHWL. Inundation frequencies (IFs) of the initially low and intermediate sites decreased between 2006 and 2014, but the IFs of the high sites increases over time. These results coincide with our hypothesis about the absence of the marsh inundation-△E feedback. Comparing marsh △E rates and sediment accretion rates shows that △E is mainly determined by the deposition of new sediments. Only at one site close to the main creek, and also in the natural marsh close to the Scheldt shallow subsidence is observed; processes in the lower layers of the soil seem to play a role in △E; marsh elevation doesn't change whereas sediment accretion continues. Preliminary results on bulk density also show a higher degree of compaction in the lower layers.