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Potential impacts of extreme storm surges on a low-lying densely populated coastline: The case of Dunkirk area, Northern France.

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Along the southern coast of the North Sea, a large proportion of the Flemish coastal plain consists of densely populated reclaimed land, much of which lying below sea level. This is the case along the northern coast of France, from Dunkirk to the Belgium border, where the shoreline consists of coastal dunes that protect low-lying reclaimed lands from marine flooding. Coastal dunes have been massively transformed or destructed due to the urbanisation and to the development of the port of Dunkirk. Along this coastline, the beach is subject to a macro-tidal range that increases from 3.5 m during mean neap tide conditions to 5.4 m during mean spring tides. The coastline is dominantly exposed to offshore to shore parallel winds from a south to southwesterly window. Although this coast is exposed to fetch-limited, relatively low-energy waves, strong onshore winds associated with low atmospheric pressure frequently result in storm surges (1-1.5 m) responsible for upper beach/dune erosion, and polder drainage problems. Indeed, to prevent the polder from being waterlogged, drainage canals and pumps drain excess water from the polder and discharge it directly into the sea at low tide.

In November 2007, strong (> 10m/s) direct onshore winds, blowing persistently during 48 hours, combined with an atmospheric pressure decrease of 23 hPa, resulted in an extreme surge with a residual tidal height maxima of 2.4 m. This surge, the largest event measured since the 1953 storm surge, fortunately occurred at low tide, during moderate tidal range conditions. At high tide, although the surge was less than 1.2 m, it nevertheless induced dune scarping and seafront promenade submersion. During this storm event, the drainage of the polder could not be operated during 24 hours, because the maximum water level over which gravity drainage can not be performed was constantly exceeded even at low tide. The peak of the storm surge occurred nearly 5 hours before high tide. If the storm surge took place only a few hours later, the consequences could have been much more severe. Damages can also occur during moderate surges however, when they are combined with a spring tide, as what happened, when a 1.1 m surge developed in March 2007.

In a context of global change and projected sea level rise, such events could induce major damages in the next future, especially if an extreme surge occurs at high tide during a spring tide. Large proportions of the urban seafront could be submerged. Furthermore, coastal dunes, which act as natural ramparts against marine flooding, could dramatically retreat and the polder could be inundated. Stakeholders will have to face increasing challenges in warning and protecting coastal communities against marine submersion and polder flooding. It is then important for the local authorities to take into account the potential impacts of such events, in order to reinforce sea defence, increase pumping station efficiency and plan warning systems, witch is it not the case yet.