Evolution of climatic forcings and potentially eroding events on the coast of Northern France

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The global increase in air and sea surface temperature which began during the late 19th century (IPCC, 2001) is expected to result in a rise in sea-level and possibly in changes in extreme climate events during the 21th century, including increasing storm intensity and frequency (WASA, 1998). Such scenario would result in an increase in storm surge frequency that may be responsible for an acceleration of coastal erosion and more frequent flooding along low-lying coastlines (French et al., 1995). The aim of the present study is to investigate the changes in frequency and magnitude of storm surges and associated meteorological forcings along the coast of Northern France during the second half of the 20th century and to assess their potential effects on coastline evolution. We present here the results obtained in the Dunkerque area (Fig. 1) where the coast consists of wide macrotidal beaches facing the Southern Bight of the North Sea and of low-elevated coastal dunes that experienced erosion since at least the middle of the 19th century (Corbau et al., 1993; Vasseur and Héquette, 2000).

The main meteorological forcings of storm surges are wind and barometric pressure. Wind speeds and directions and barometric pressure from the Dunkerque weather station were analyzed for the period 1956-2001. Available data consist of three-hourly mean pressure, three-hourly mean wind speed and direction. Maximum daily instantaneous wind speed and corresponding direction are also available but only for 1960 to 2001. Theses data were used to analyze the evolution of storm events which are potentially the most significant for coastal dynamics, and specifically the evolution of: (1) of the frequency and duration of wind events characterized by three-hourly mean speed $\geq$ 16 m.s^{-1} and of maximum instantaneous wind speed $\geq$ 28 m.s^{-1}, (2) low atmospheric pressure events, (3) onshore wind events. A study of the evolution of storm surges has also been carried out, using predicted tide levels and recorded water levels measured in the Dunkerque harbour between 1956 and 2001, the storm surge value being the difference between predicted and observed water level.

Along a macrotidal coast like the coast of Northern France, the occurrence of erosive events is strongly controlled by the daily tidal range and by the coincidence of the storm event with high tide (Fig. 2); a major storm occurring at low tide or on a day of small tidal range would have less effect on the coast than a lower magnitude storm taking place at high tide during spring tide. Since the impacts of storms on the coast closely depend on the tide level, we computed a storm impact index (Zhang et al., 2001) taking into account the storm surge magnitude, the dune to elevation, and time duration during which this level is exceeded by the water level.

Our first results show that storm events and potentially eroding events tend to decrease during the study period. Although the number and frequency of storm events shows a decreasing trend (Fig. 3), periods of increased storm activity can be distinguished, the 1956-1962 and 1972-1977 periods representing 58% of the total observations of wind speed $\geq$ 16

m.s^{-1} recorded between 1956 and 2001. These results are consistent with the analyses of the evolution of instantaneous wind speed ≥ 28 m.s^{-1}, low barometric pressure events, and storm surges ≥ 100 cm.

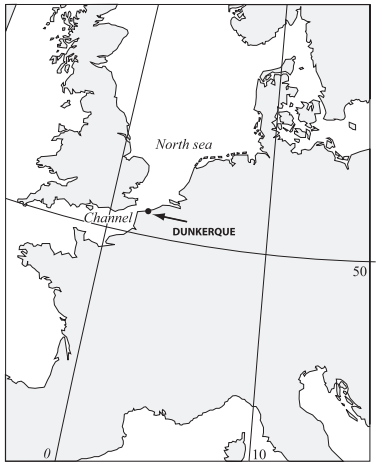

figure 1- Location

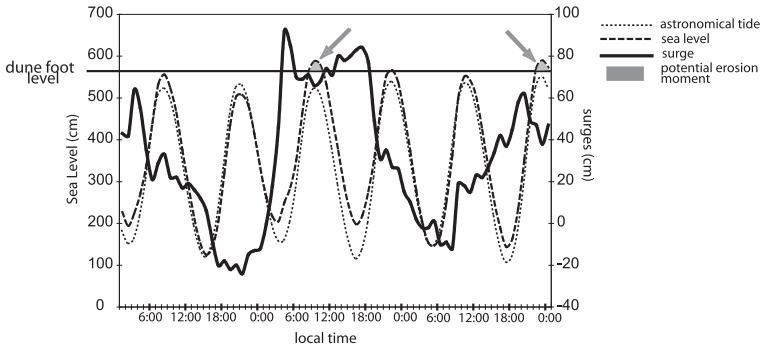

figure 2- Along a macrotidal beach potential erosive high waters correspond to the coincidence between high tide and surge value. With this correspondance sea level exceed the dune foot and erode. The intensity of erosion depend of the time too.

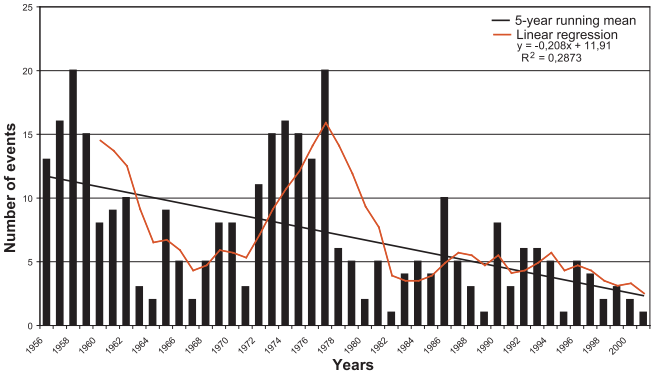

Figure 3 - Number of tempetuous events with wind >= 16 m.s^{-1} at Dunkerque

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