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Shoreline sandwaves along the Aquitanian Coast (France): influence of climate change

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1. CONTEXT

Climate change induced vulnerability is defined by the Intergovernmental Panel on Climate Change (IPCC) as the combination of sensitivity to climatic variations, probability of adverse climate change, and adaptive capacity. As stated by the IPCC (Watson et al., 1997), the "coastal systems should be considered vulnerable to changes in climate".

Within the French ANR VULSACO project (VULnerability of SAndy COast to climate change and anthropic pressure), the present day erosion tendencies as well as the potentially future erosion trends are investigated. In the present work, shoreline sandwaves are considered. These morphologic features are shoreline undulations with typical wavelengths of several kilometers (Ashton et al., 2001). They generally appear under high angle incidence waves (Ashton et al, 2001; Falques and Calvete, 2005). These types of rhythmic feature is found for instance along most of the Dutch coast (Falques, 2006).

The French Aquitanian Coast is mainly composed of sandy beaches, along more than 230 km. This area is characterized meso-macrotidal semi-diurnal tides and exposed to energetic waves (Hsmean$\sim$1.5 m). Furthermore, this area is characterised by the presence of an outer crescentic bar and an inner bar exhibiting rather regularly spaced rip channel with a mean wavelength of 700 m and 400 m, respectively. These nearshore rhythmic patterns are likely to be mirrored at the shoreline.

Here we present the shoreline stability of the French Aquitanian coast under present day wave climate. In addition, the influence of a change in the wave regime under climate change on the shoreline undulations is investigated.

2. DATA ANLYSIS

The presence of shoreline sandwaves on the Aquitanian coast has never been investigated so far. Several sets of shoreline data have been used. One set was based on vegetation limits detected by remote sensing (data from OCA Aquitaine Coast Observatory , covering several decades). The other one was based on Digital Elevation Models and tidal model (Histolitt data, SHOM-IGN). Several approaches, including Fourier transformation, wavelet analysis and E.O.F. have been used to characterise shoreline sandwaves along the Aquitanian Coast. The data analysis shows the occurrence of shoreline undulations with typical wavelengths of 2, 4, 8, 10-15 and 30 km.

3. PRESENT DAY SHORELINE INSTABILITY

The one-line modeling is a well known tool in coastal engineering. It is often used to predict changes of the coastline position. This approach, which is based on the computation of wave-driven alongshore sediment fluxes, is known to smooth the coastline irregularities. However it has been shown that high wave angle with respect to shore-normal can induce the development of shoreline instabilities.

Falqués and Calvete (2005) extended the classic one-line formulation by performing a linear stability analysis. Using this method, they showed that not only the occurrence of high angle incidence wave instability depends on the wave angle but it also depends on the wave height and periods. This model, so-called 1d-morfo, also confirmed the existence of HAWI (High Angle Wave Instability).

The 1d-morfo (Falques, 2006) model is applied to simulate the appearance of shoreline sandwaves along the Aquitanian coast. A typical winter (February 2008) profile is used (ECORS/SHOM 2008 campaign) and three tide levels are considered (Low/Mid/High tide). The local wave regime forcing has been analysed using a data clustering algorithm (Butel, 2002) applied on long time serie of wave data (GFS/NWW3). With this method, ten

wave classes representative of the present wave climate have been obtained and introduced as wave input of the model.
At mid-tide and high tide, the model exhibits some instability, with wavelength comprised between 400 and 1200 m and time scale of few days.
This wavelengths falls in the range of the crescentic bar wavelengths, rather than the shoreline wavelengths obtained with the shoreline analysis.

4. SENSITIVITY STUDY REGARDING CLIMATE CHANGE

The model and literature review on climate change show that the few prediction of wave conditions available for the future deal mainly with the significant wave height, and not so much with the wave direction or period. To compensate this lack of knowledge, a sensitivity study is done to get information on the possible changes within the next decades (2030). It consists in studying the influence of a modification in the characteristics of the present day wave classes within a reasonable magnitude order. The aim is to precise whether there is some threshold above which the instabilities could be damped. The results of this sensitivity study will be presented at the EGU conference.

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