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Video Monitoring of soft coastal defenses at the Lido of Sete, France

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Abstract :
The feedback on soft techniques against erosion is still limited nowadays, and does not allow to determine if such techniques are efficient or not, and if they are applicable to similar environments. The site of the Lido of Sete is currently evaluating these techniques and thus provided an outstanding natural setting to analyze coastal behavior associated with soft defenses. An Argus video monitoring system was deployed in 2011 to survey this area. The monitoring before, during and after the management works permitted to describe the natural evolution of the beach and nearshore area, and the morphological response following the deployment of a submerged geotextile wave breaker. The bar system, characterized by well-developed crescentic patterns was linearized and progressively rotated to become parallel to the geotextile. Consequently, the beach began the same rotation, inducing a shoreline advance of 15m. After this period of adaptation, the system of bar/shoreline remained quite stable, and morphological response to storm events significantly decreased as it was observed during the storm of November 2014. These results indicate a quite efficient response of the site to the deployment of the geotextile. Additional surveys of the wave breaker state are currently undertaken by the local authority to obtain a full feedback on the resistance and durability of this kind of protection against coastal erosion.
Key-words: Video Monitoring, ARGUS, Submerged wave breaker, Nearshore bars, Storm impact.

1. Introduction

Along the Mediterranean coasts, new soft techniques of defense against coastal erosion were deployed during the last years: geotextile wave breaker or groins, beach dewatering systems, ... The feedback on these new techniques and their applicability in microtidal environments remains rare and it is thus difficult to link the observed changes with these structures and to fully understand why it works or not at a given site. These techniques were deployed on the site of the Lido of Sete providing an exceptional laboratory to analyze coastal behavior associated with soft defenses.

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2. Field site

The Lido of Sète is a narrow coastal Barrier facing the Mediterranean Sea. The site is representative of many of the Mediterranean beaches since it is exposed to a very irregular wave climate: very low wave energy on average, but very intense during the winter storms (Hs_{mean}=0.7 m, but Hs can reach more than 7 m during extreme storm events). The mean shoreface slope is around 0.9% and grain size about 200 µm for the nearshore bars (CERTAIN *et al.,* 2005). The inner bar, 2 m high, is located between 80 and 170 m from the shoreline and its crest is around -2 m from the sea surface. The outer bar distance is between 250 m and 400 m with a crest depth around 4 m. It is between 2.5 and 3 m high.

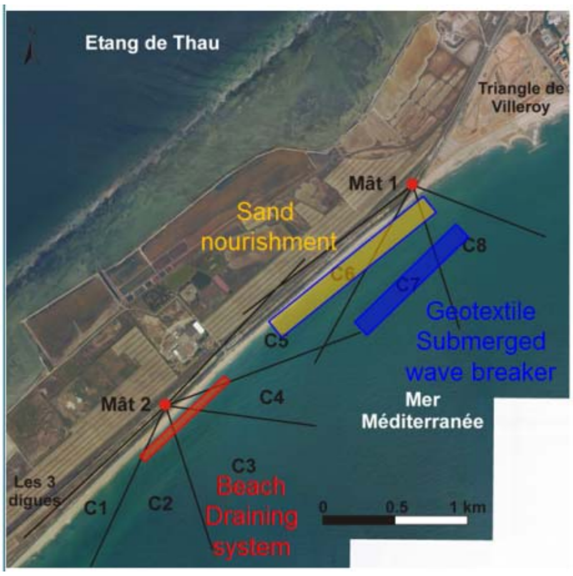

Figure 1 Presentation of the Lido of Sete field site with the location of video cameras and soft defenses experimentation areas.

This microtidal site is a very attractive sandy beach that underwent significant shoreline retreat during the last decades. Consequently, an important management project was implemented, involving the retreat of the coastal road, dune rehabilitation, beach enlargement, and the deployment of a submerged geotextile breakwater and a beach dewatering system. An Argus station was installed in 2011 to monitor this experimental deployment.

This contribution deals with the morphological evolution of the site before and after the deployment of the submerged breakwater in the beginning of 2013 (end of work is March 2013). This defense is composed of 60 m long geotextile containers and extends over 850 m. The containers are 3 m high and located on the external bar at approximately 350 m from the beach in 4 m water depth. The water depth over the structure is between 0.5 and 1 m and the main objective of this deployment is to induce the breaking of all waves having significant heights over 2 m (FRAYSSE, 2009).

3. Methods

An Argus video monitoring system (HOLMAN & STANLEY, 2007) was deployed in 2011 at Sete beach. The video monitoring system consists of 8 cameras mounted on two 20 m high masts. The distance between the masts is 2.5 km, and the covered area is around 4 km (Figure 1). Snapshots and 10 min averaged images are recorded each 30 min as well as pixel intensity time series. Cross shore resolution is very good (0.1 to 4 m at 1000 m of the mast), and longshore resolution is ranging from 1 m to 30 m at 1000 m of the mast. Images of the 8 cameras are rectified and combined using Argus toolbox.

The morphological features (bar, shoreline) are extracted using ARGUS toolboxes. Extraction of the bar is done through the sampling of the pixel luminosity intensity using BLIM toolbox (POPE, 2008).

Wave (at 30 m water depth) and water levels (in the harbor of Sete) are measured in the vicinity of the study area by the regional government administration (DREAL-LR).

A particular interest was put on nearshore bars and shoreline evolution before and after the deployment of the geotextile submerged breakwater to evaluate the morphological response of the site and the efficiency of this soft defense.

4. Results

The video monitoring enabled to describe a rapid dynamics of crescentic nearshore bars that were supposed to be quite stable. Processes of longshore migration, linearization and generation of new cusps after storm, already observed in other microtidal environments by ARMAROLI and CIAVOLA (2011), were documented, as well as a strong relationship between inner bar dynamics and shoreline sinuosity (BALOUIN *et al.*, 2012). After the deployment of the geotextile, a progressive linearization and rotation of the inner bar (parallel to the tube) was observed. This process induced a progressive rotation of the shoreline parallel to the bar and the geotube associated with a beach enlargement (around 15 m) while this part of the beach was retreating very rapidly before the deployment (10 m in 2 years). After this rotation of the bar and the shoreline which became parallel to the submerged wave breaker, the position of both bar and shoreline remained quite stable, indicating that the system probably reached a new equilibrium state.

The 3D patterns, both in the bar and emerged beach progressively disappeared, inducing an important modification of wave run-up that was previously driven by beach sinuosity and beach cusps. With this new beach morphology, storm run-up is more regular alongshore, and only major events can reach the dune front and generate impacts.

A particular attention was paid to a major SE event that occurred at the end of November 2014. Wave significant high reached more than 5 m and this level of storm energy is typically associated with a shoreline retreat between 10 and 20 m (GERVAIS *et al*., 2012).

During this event, the beach was totally submerged, the swash reaching the foot of the dune, with locally overtopping of the dune crest. However, video images before/during and after the event indicate that the shoreline retreat was not effective. Only a few hours after the event, the beach had recovered its initial width, suggesting a very good resilience that is probably due to the presence of the wave breaker nearshore.

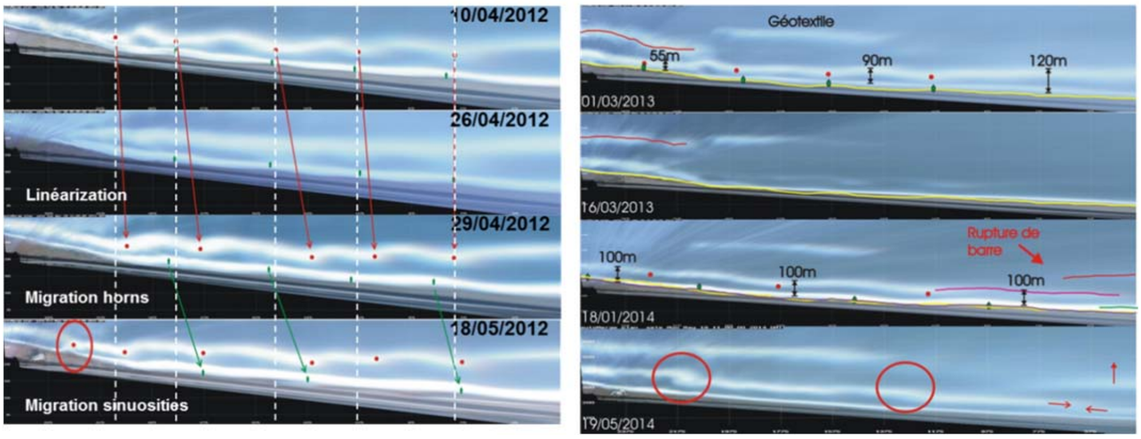

Figure 2. Evolution of the nearshore bar system during storms before (left) and after (right) the deployment of the geotextile wave breaker.

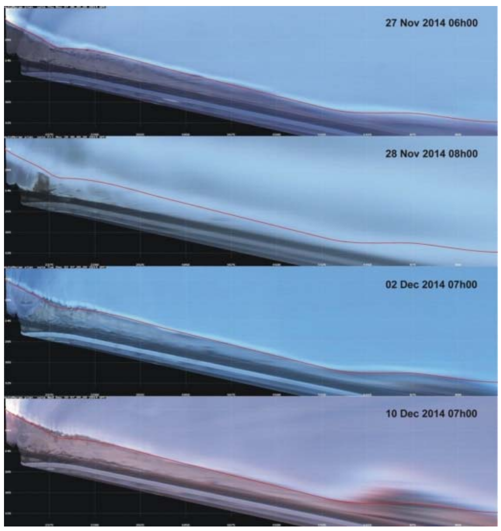

Figure 3. Combined and rectified timex image of the beach in front of the submerged wave breaker during the storm event of Nov 28th. Images indicate the situation before, during and after the event. Red line is the position of the shoreline before the storm.

5. Conclusion

The monitoring of the Lido of Sete beach before and after the deployment of soft defenses permitted to obtain a very detailed and quantitative information on the nearshore bars and beach response to the geotextile. Results indicate that after an initial period, the system got to a new equilibrium state characterized by the rotation of the bar and shoreline parallel to the wave breaker. Moreover, monitoring during several storms and a major event in November 2014 suggests the efficiency of this structure on the Lido of Sete during storms. Monitoring is on-going to evaluate the impact on adjacent coasts, and a survey of the wave breaker state is currently undertaken by the local authority to obtain a full feedback on the resistance and durability of this type of protection technique against coastal erosion.

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