MONITORING BARCELONA CITY BEACHES USING VIDEO (ARGUS) AND LASER (LIDAR) METHODS

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Abstract

This contribution presents video camera and laser techniques describing the coastline evolution in Barcelona city beaches over a 4-month period during 2002. LIght Detection And Ranging (LIDAR) measurements were obtained by the Institut Cartografic de Catalunya in April, 17 and July, 23, whilst Argus measurements were obtained from Mapfre station by the Instituto de Ciencias del Mar hourly from April to July. Both techniques' ability to locate the coastline is compared, obtaining similar results. Argus high temporal resolution sampling in conjunction with LIDAR three-dimensional view of the emerged beaches, more spaced in time, appears to be a valuable procedure for monitoring the beaches.

Keywords: Argus, LIDAR, coastline evolution, Barcelona

Introduction

The objective of this study is to examine the evolution of three beaches of Barcelona (Barceloneta, Nova Icaria and Bogatell) using the technology provided by Argus and LIDAR (Fig. 1).

Coastal cartography is one of the main applications of LIDAR. It has many advantages over aerial photogrammetry in coastal areas, accuracies around 10 cm in height and sampling densities around 1 point/m^2 are easy to achieve with the system.

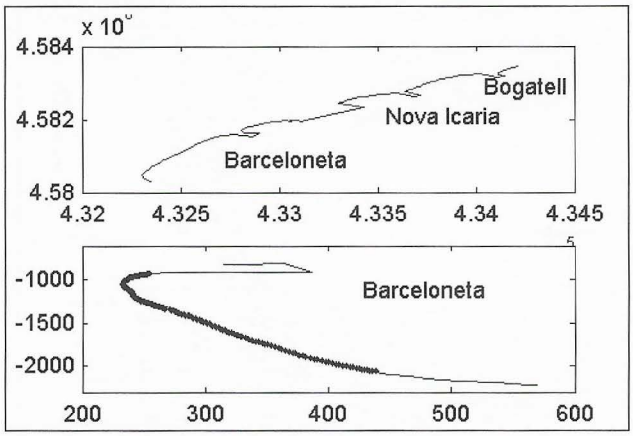

Fig. 1. *Top*: studied beaches in Barcelona (UTM). *Bottom*. LIDAR and Argus coastlines represented in local coordinates (meter). LIDAR in light black line, Argus in bolded line.

Two flights were done in 2002, at an altitude of 2,300 m over the coast of Barcelona to demonstrate the possibilities of this technique: on April 17 and July 23. In both cases the point density was 0.5 point/m^2 and a digital terrain model (DTM) of 1-m grid step was computed (1).

The ARGUS system (2) is an automated video station, comprising five video cameras connected to an image processor, which controls the communication to the outside world. The station placed on 21st October 2001, monitors Barcelona city beaches (3). It is located atop Mapfre building (approximately 146-m high) covering a 2-km radio and spanning a 180° view. Sampling every daylight hour in a ten minutes register (http://argus.cmima.csic.es).

Since Argus installation in October 2001, a highly energetic period occurred in the region with important storms (November, December 2001; January, March 2002) producing extensive sediment transport and severe erosion problems. Approximately a week prior to the first flight with LIDAR, a storm with E direction and significant wave height (Hs) of 2.6 m (4) took place in the region (April, 11-12). Moreover the beaches situation changed over the study period, due to a second storm coming from the East (May 7-8), with maximum Hs reaching 3.8 m (4). Finally, a beach nourishment (150 000 m^3) was carried out in Barceloneta and Bogatell beaches (June 13 to July 17).

Coastline evolution

The impact of single storm events is derived from Argus images. Extraction of coastlines and images examination reveals that, as pointed above, the coastline previous to the May storm find an eroded beach due to the unusually energetic wave pattern. This can explain the fact that the beach erosion was of the same magnitude than during the less energetic storm taken place in April.

The storm occurred in May produced three different erosion patterns on each of the beaches. Bogatell´s coastline suffered erosion/accretion, eroding 10 m in the northern side and accreting around 5 m in southern part. Nova Icaria did not show significant differences, whilst Barceloneta suffered a landward migration of about 5 m.

Nourishment took place from June 13 to July 5 in Bogatell and July 5 to 17 in Barceloneta. Using Argus images the nourishment effectiveness have been studied by means of temporal variations of the coastline in given locations of Bogatell and Barceloneta. It has been seen that the replenishment of the beaches evolves, with erosion happening until some stabilization is reached.

LIDAR *versus* Argus coastlines

An important point in this study is the comparison of the results obtained using both methodologies. Two different coastlines were derived from LIDAR. The first one using the texture of the DTM to discriminate the sand from the sea. A shadow map was computed from the DTM with a very low illumination source and the coastline was drawn from this image. The second coastline was derived from the intensity map of the pulse return. The most similar results were obtained using the second method (Fig. 1).

With LIDAR the volumes of sand displaced can be accurately measured from the differences of DTMs. As the sensor cannot take bathymetric measurements, the sand added or removed under water is not taken into account in the calculations. Using this method and the LIDAR-derived coastlines it has been estimated in Bogatell an increase in volume of around 24000 m^3 corresponding to an increase in surface of 12000 m^2. This corresponds to 2 m^3 /m of sand necessary to get a coastline accretion of 1m.

Conclusions

The study of Barcelona beaches using video images reveals that, despite the fact that they are closed beaches due to man-made structures, they have differential morphological evolution. Argus provides high-resolution information about shoreline changes after storms and beach nourishment.

Argus and LIDAR methods offer similar results for measuring the coastline position. LIDAR capability to measure 3D characteristics supplies accurate measurement of volume changes in the emerged beach.

Argus and LIDAR are complementary methods in morphodynamic studies. It is suggested to combine both techniques in order to obtain precise information of the beach evolution, persist in Argus continuous sampling, adding 3D information from specific LIDAR surveys.

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