Analysis of the Ciara storm impact on a multibarred beach at the Belgian coast

A. Pintor, A-L. Montreuil, M. Chen, P. Bogaert
albert.pintor@vub.be

Introduction

The coastline is a highly dynamic sea-terrestrial interface. Sandy beaches are important for the economic and recreational activity as well as for coastal protection. Intense events of storms can damage the beach and modify its morphology.

Ciara storm took place between 8-12/02/2020 in Belgium and lashed with significant economic and environmental damages.

Five beach profiles were surveyed perpendicular to the coast before and after the storm in order to assess storm impact on intertidal bars (Fig 1.B).

The aim of this study was to analyze the effect of the Ciara storm on the morphodynamical and volumetric changes of the intertidal bars.

Study site

The Belgian coast extends for 67 km and is oriented SW-NE along the North Sea basin (Fig 1). The coast is subject to a large tidal environment with a low to moderate wave regime. The study site is located at Groenendijk, a natural wide sandy characterized by a multiple bar system in the intertidal zone.

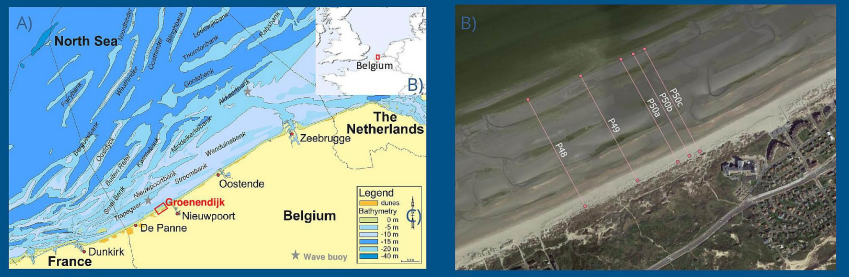

Fig 1. Map of the study site. B) Beach profiles surveyed.

Methods

A monitoring campaign after Ciara storm was carried out with RTK-GPS from 22/02/2020 till 26/02/2020. Also, a pre-storm LiDAR topographic survey on 13/01/2020 and post-storm airborne LiDAR

Bar parameters were obtained such as the different bars width and height, distance between adjacent bars, seaward and landward bar slopes, bar volume etc (Fig 2.B).

survey on 28/02/2020 were performed.

The acquired cross-shore profiles were re-projected and interpolated at 1 m interval. A second order polynomial was fitted on the elevation profiles to locate the crests and troughs positions where the difference between them is maximum (Fig 2.A). Then morphological analyses were carried out to determine bar dynamics over the study period.

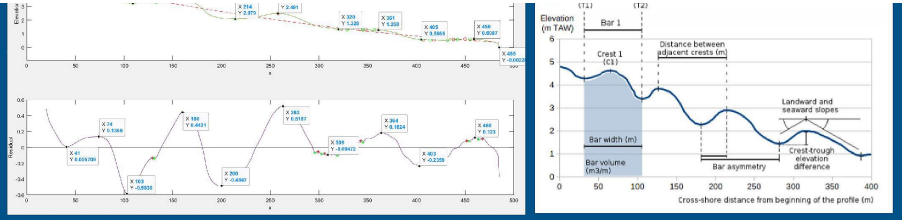

Fig 2. A) Obtention of the position of the crest and throughs of the bars. B) Bar parameters definition.

Results

Ciara storm was one of the biggest meteorological events of the last decade (maximum water level and wave height of 5.78m (TAW) and 2.8m respectively) and it doubtlessly impacted the beach morphology. The main findings were:

- A high difference of elevation in the crest and troughs of the bars between pre- and post-storm was found with standard deviation (SD) values up to 0.3m, and up to 0.15m by focusing only on the post-storms daily campaign with SD higher values on the seaward slopes of the bars.
- The most significant changes occurred on the seaward slope of the bars. Interestingly, the most inner bars were dynamics while the bar near the mean low water level was stable.
- The storm impacted the beach and produced an overall loss of sand (up to 0.5 m^3/m).
- Bars were probably migrated seaward after the storm.

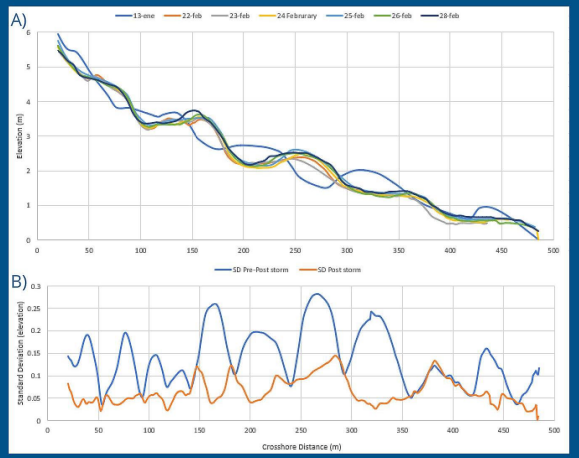

Fig 3. A) Time series of elevation profile at P50b, first bar is located on the upper beach. B). Standard deviation for pre- and post-storm survey and between post-storm surveys for "P50b" profile.

Table 1. Bar parameters comparison between 13/01 (pre-storm) and 24/02 (post-storm)

13/01 – 24/02	Migration of the bar crests	Diff Crest Elevation	Diff Bar Width	Diff Bar Volume
Bar Number	(m)	(m)	(m)	(m^3/m)
1	37	-1.04	15	-0.46
2	25	-0.13	5	-0.33
3	33	-0.14	4	-0.30
4	40	-0.72	-46	-0.29
5	23	-0.36	11	-0.11

Future Research

This study has provided insight into storm impact on multibarred beach and further investigations will be carried out on beach recovery. These would be beneficial for coastal management and future research.

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