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SMARTPHONE BASED SHORELINE MONITORING: AN INTERSITE COMPARISON IN LESSER ANTILLES

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1. Introduction

Understanding and predicting shoreline change along sandy coasts are essential for coastal management and adaptation to climate change. In Lesser Antilles, high percentage of the population is concentrated along the coast although various natural drivers can cause abrupt shoreline changes such as hurricanes. While short time scale shoreline variability (few days) were often mentioned (e.g. Pillet et al., 2019), the overall shoreline dynamics have been rarely studied for those areas.

One solution to better understand and anticipate shoreline changes is to monitor shoreline position at the highest possible frequency over the longest possible period. For this purpose, a coastal monitoring network has been established on the island of Martinique (Lesser Antilles) in 2017 (www.observatoire-olimar.fr), including several low-cost smartphone-based cameras installed at different sites. These cameras allows obtaining for the first time in Lesser Antilles high frequency data for several years at sites of which spatial extent is of the order of hundreds of meters.

This study aims to compare and contrast shoreline behavior for two study sites in Martinique with the use of low-cost smartphone-based cameras.

2. Field Sites

Le Carbet beach is a 4 km long west facing beach composed of fine volcanic sand. It is a semidiurnal microtidal environment, exposed to a low-energy wave climate. The annual mean significant wave height is 0.2 m with peak period of 9 s. Higher-energy wave-events occur generally during the hurricane period (July to October) or later during the wet season (~ until March) with wave heights reaching 1.5 m.

Anse Charpentier is a 1 km-long northeast facing beach composed of fine sand although coarser sediments may also be present on its ends. The beach is open to the Atlantic Ocean and thus exposed to a more energetic wave climate. The annual mean significant wave height is 1.4 m with peak period of 8 s. The tidal regime does not differ from above.

3. Method

Wave characteristics were derived from WaveWatchIII model, operationally running for sea state forecasting on <http://marc.ifremer.fr>. Wave data were extracted at the 50 m isobaths at the vicinity of each of the two study sites. Water levels were computed with the global tidal model TPXO9 (<https://www.tpxo.net/global>).

Deployed at both study sites, the video monitoring system consists in a smartphone-based camera installed at beaches ends at approximately 20 to 30 m high from the mean sea level. The camera has been collecting images during the last 5 years at Le Carbet beach while it has been deployed later at Anse Charpentier, since August 2021. Over the studied periods, 2018-2022 (Le Carbet beach) and 2021-2022 (Anse Charpentier) the video monitoring system has experienced few malfunctions with an average of less than 15 % failure in the acquisition of hourly images.

Images were transformed to real-world plan view images (Holland et al., 1997) on a 0.50 x 0.50 m grid that extend 250 m in the cross-shore and 500 m in the alongshore direction. Shoreline position was extracted (Harley et al., 2019) approximately every 3 days for low-energy wave conditions near mid-tide to limit sea level variations-induced errors. Beach width was computed from the vegetation line with maximum error estimated between ± 3 m and ± 6 m according to the precautions taken by the operator.

4. Results

Our results highlight complex shoreline dynamics at both study sites with different behaviors. At Le Carbet beach (Figure 1a), we observed an important seasonal variability of the shoreline position that can reach 10 m in one year (see the regular alternation of blue/yellow patterns in Figure 1b). These changes are more important at one end of the beach, producing beach rotation, correlated with seasonal changes in wave direction, suggesting an important role of longshore transport on the lower beach system.

At Anse Charpentier (Figure 1b), a clear seasonal behavior is more difficult to observe since the camera was recently installed. On shorter time scales (few days), abrupt shoreline changes were registered with variations sometimes exceeding 10 m. Most of these oscillations can be related directly with significant wave heights with larger waves enforcing shoreline retreat. Interestingly, we also occasionally observe local (on a few tens of meters alongshore) significant shoreline retreats (white stars in Figure 2b) while wave energy remains moderate. Such a behavior generally occurs in the vicinity of rip channel morphologies and results in a brutal decrease of beach width and an increase of the alongshore shoreline variability (Figure 2a).

These findings highlight the different and contrasted shoreline dynamics in Martinique and that are likely to occur elsewhere in Lesser Antilles. In this context it can be hazardous to infer future shoreline position for those areas without the knowledge of the dominant mode of variability.

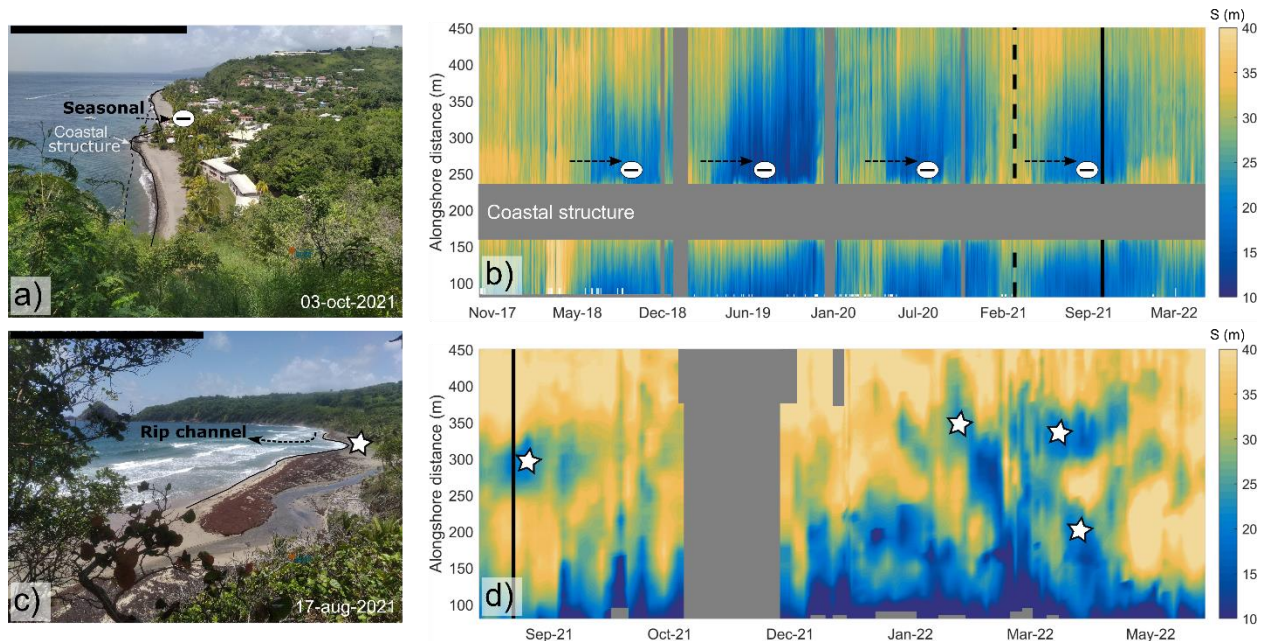


Figure 1. Raw images at Le Carbet Beach (a) and Anse Charpentier (c) with alongshore beach width (S) time series for both study sites (b, d). Black arrows with minus symbols illustrate seasonal shoreline retreat at le Carbet beach (b). At Anse Charpentier (d), white stars point out perturbations on shoreline enforced by rip currents. Grays areas denote the absence of data.

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