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▶ **To cite this version:**

Olivier Burvingt, Bruno Castelle, Vincent Marieu. Coastal dune response to extreme storms and multi-annual recovery along the atlantic coast of Europe. Coastal Sediments 2023, Apr 2023, New Orleans, United States. pp.588-595, 10.1142/9789811275135_0055 . hal-04266577

HAL Id: hal-04266577
https://hal.science/hal-04266577

Submitted on 2 Nov 2023

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COASTAL DUNE RESPONSE TO EXTREME STORMS AND MULTI-ANNUAL RECOVERY ALONG THE ATLANTIC COAST OF EUROPE

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1. Introduction

Coastal dunes are natural barriers buffering storm waves, protecting coastal communities from flooding and rising sea level, and providing a valuable source of biodiversity for the surrounding environment (Grootjans et al., 2008). Although coastal dunes have received quite a lot of attention over the last decades (Hesp and Walker, 2013), knowledge gaps remain, and our understanding of long-term (years to decades) coastal dune evolution remains limited. The large diversity of coastal dunes along the Atlantic coast of Europe and the sequence of extreme storms observed during the 2013/14 winter, considered as the most energetic storms since at least 1948 (Masselink, 2016), represent a unique opportunity to study the spectrum of coastal dune response and recovery from an extreme winter.

2. Methodology

A large dataset of high-resolution airborne LiDAR topographic surveys collected from 2011 to 2020 at 8 study sites spread along the Atlantic coast of Europe (Figure 1) was used herein. The 8 stretches of coastal dunes selected for this study are located, from north to south (Figure 1), at Formby beach (Merseyside, UK), Perran Sands (Cornwall, UK), Gwithian (Cornwall, UK), Notre-Dame-des-Monts (Vendée, France), Carcans (Gironde, France), Lacanau (Gironde, France), Truc Vert (Gironde, France) and Lette Blanche (Landes, France). These coastal dunes are all facing NW-W and are therefore fully exposed to Atlantic storms. They vary in size (from 100 to 200 m wide), in height (culminating from 10 to 45 m) (Figure 1), and back sandy beaches with different beach states and geological settings (e.g. from fully open to embayed beaches). Several parameters, such as sediment volume changes (V), dune foot horizontal changes (dX_{foot}), and dune crest vertical changes (dZ_{crest}) were computed from the LiDAR data to assess their responses to, and recovery from, the extreme winter of 2013/2014.

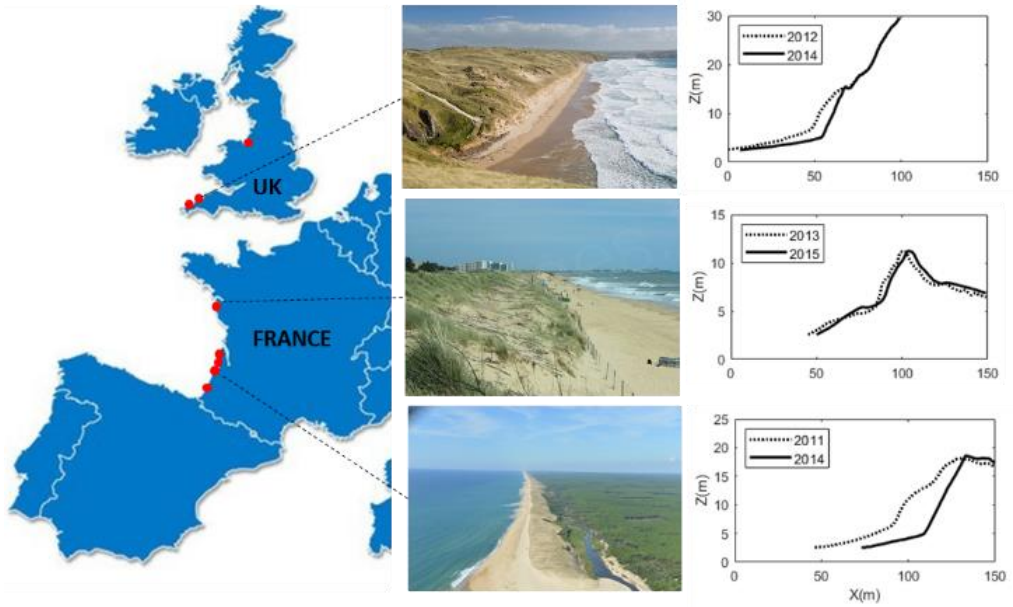

Figure 1. Location map, pictures, and pre-storm/post-storm dune profiles at three study sites.

3. Results

Results show that the coastal dunes of the 8 study sites lost large volume of sediment during the 2013/14 winter (from -20 to -300 m^3/m) (Figure 2). During that winter, coastal dunes either retreated or translated landward by tens of meters (Figure 1). Nevertheless, in most cases the dune crest elevation rose over this storm period and even further during the subsequent years. It was also shown that controlling factors related to the dune and/or beach morphology (slope, height, size, sandbar position…) explain the intra- and inter-site variability of the different storm responses. Recovery was also very variable between the different stretches of coastal dunes studied here. They either rapidly fully recover, or only show partial recovery or even further erosion (Figure 2). The factors that control recovery processes were also analyzed to explain such intra- and inter-site variability, which will presented at the conference.

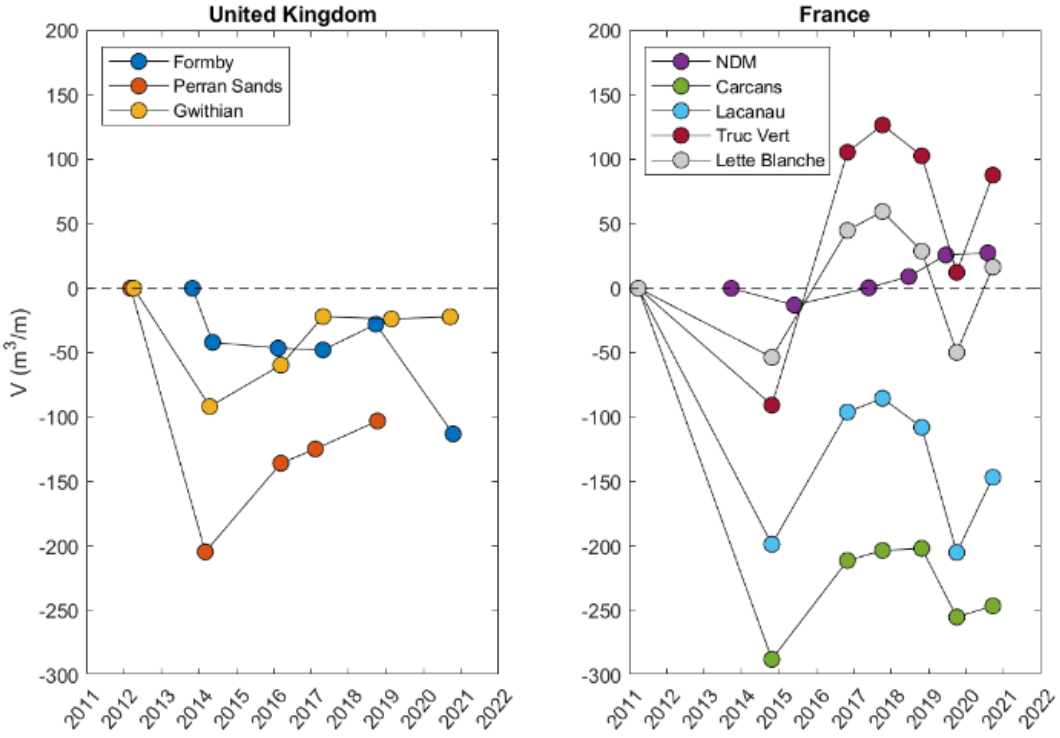

Figure 2. Multi-annual time-series of the sediment volumetric changes, V (m^3/m), at the 8 study sites.

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