

## Impact case study (REF3)

<b>Institution:</b> Edge Hill University		
<b>Unit of Assessment:</b> C14 Geography and Environmental Studies		
<b>Title of case study:</b> Coastal dune evolution and management		
<b>Period when the underpinning research was undertaken:</b> 2013-2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b> Professor Irene Delgado-Fernandez	<b>Role(s) (e.g. job title):</b> Professor of Coastal Geomorphology	<b>Period(s) employed by submitting HEI:</b> 2012-present
<b>Period when the claimed impact occurred:</b> 2016-2020		
<b>Is this case study continued from a case study submitted in 2014?</b> N		
<p><b>1. Summary of the impact</b>  Research at Edge Hill University has informed institutions and policy makers involved in coastal dune management in Spain and the UK, significantly impacting management practices related to landscape planning and handling of human stressors, and also raising broader public awareness around preservation of coastal dune environments. Our underpinning research has advanced fundamental understanding of the roles of climate change and anthropogenic activity on coastal dune vegetation disturbance and dune field evolution, as well as demonstrating how detailed monitoring of aeolian processes and dune mobility are key aspects of dune restoration. This work has generated recommendations that are contributing to enhanced policy development, science communication and changing public attitudes via ongoing dialogue with coastal managers in Britain and abroad. Significantly, the work is making a major impact on the preservation of important natural environments along Spanish coastlines.</p>		
<p><b>2. Underpinning research</b>  The underpinning research for this impact case study includes investigations of coastal dune evolution intended to inform clear strategies for managing coastal environments. The research is a product of several on-going collaborations between EHU Professor Irene Delgado-Fernandez and international colleagues from Australia, Canada, Spain and the UK. Initial research in 2013, funded by a small internal pump-priming grant, helped quantify the growth of dune vegetation and proposed a method to differentiate between 'natural' vs. 'artificial' changes to the proportion of dune vegetation cover <b>[R1]</b>. This is important because approaches to managing coastal dunes differ markedly depending on the driver for dune change.</p> <p>Initial results met with a favourable response from regional coastal dune managers and led to a grant from Natural England (ECM 6888) to investigate physical processes involved in the maintenance of 'pockets' of bare sand in otherwise vegetated coastal dune fields, and their potential role in dune field evolution <b>[R2]</b>. High resolution monitoring and modelling of wind and aeolian transport at the Devil's Hole blowout (one of the largest parabolic dunes in Britain, and the largest at the Sefton coast, which is in turn the most extensive coastal dune field in England) provided, for the first time, a clear picture of the magnitude of wind-driven sand transport in these settings. Over 4 tonnes of sand was transported through the dune landform in 3 hours, pointing to the efficiency of parabolic dunes and blowouts for facilitating sand movement. This research led to an invited presentation at the International Conference on Aeolian Research in Bordeaux in 2018, as well as a series of presentations at regional meetings with coastal managers. Empirical data pointed to human impact and the trampling of vegetation by pedestrians as the main cause for bare sand and dune mobility in areas such as Devil's Hole. This valuable knowledge has direct implications for management, whereby people movement can be controlled to lessen negative environmental effects on coastal dune fields.</p> <p>The NE grant helped fund PhD research by Nicholas O'Keeffe on the effect of blowouts and dune notches on beach-dune interaction, a theme that Delgado-Fernandez had previously investigated with Dr Miquel Mir-Gual when he visited the Coastal Studies Lab at EHU as a PhD student (he is currently the Minister of the Environment and Territory of the Balearic Islands Government). When trampling occurs within the dune system (e.g. <b>[R2]</b>) its effects are localised. But when trampling occurs at the frontal dunes (e.g. <b>[R1]</b>) it can lead to artificial development of blowouts and parabolic dune shapes that have implications for</p>		

coastal resilience. While active blowouts inside dune fields do not interact with marine processes, those located at the frontline of coastal dunes have a profound effect on beach-dune interaction, because they act as ‘sand corridors’ and allow beach sand to by-pass the foredunes. In natural coastlines, this mechanism inputs fresh sand to landward dune areas that experience sediment accumulation and dune growth. In disturbed coastlines subject to intense visitor pressure such as those included in this case study (Britain and other European areas, [R3]), human impact can artificially enlarge blowouts, leading to dune fragmentation, instability and eventually coastal erosion [R1, R2].

Research undertaken both in Sefton and in the island of Mallorca (Spain) pointed to the need to prevent visitor trampling and artificial development of blowouts to protect foredunes and preserve their role as coastal defence strategies. Interestingly, these results are at odds with some current management practice in Britain, where coastal dunes are actively destabilised by machinery for the purpose of triggering dune mobility. In fact, this practice, known as ‘dynamic restoration’, has recently been encouraged by way of multi-million-pound EU funding for artificially creating bare sand areas in several of the most important dune fields in England and Wales. The sharp contrast between this practice and our findings (alongside other academic literature) has led to an ongoing research vs. practice debate, initiated by a paper led by Delgado-Fernandez and co-authored by Prof Robin Davidson (University of Guelph, Canada) and Prof Patrick Hesp (Flinders University, Australia), two of the most senior coastal dune geomorphologists and beach-dune experts world-wide [R4].

Vegetation trampling and/or controversial management approaches leading to bulldozing coastal dunes are not the only risks to sand coastlines. Collaborative research with García-Romero and colleagues from the Universidad de Las Palmas de Gran Canaria resulted in in-depth understanding of the evolution of arid dune fields subject to urbanisation and other direct human impacts such as the presence of infrastructure. This research started when García-Romero visited the Coastal Studies Lab at EHU as a PhD student, and led to the measuring and modelling of aeolian transport processes [R5] and long-term impacts of urbanisation [R6] in Maspalomas dune field, one of the most environmentally, as well as socio-economically, valuable dune fields in Gran Canaria.

Coastal dunes are key sub-units in sandy coastlines. They form when an excess of sand accumulates at the rear of a beach under wind action. They store sand that is trapped during storm events and then returns to the beach during periods of calm weather, forming a dynamic and effective buffer against storm surge and coastal erosion. Because of their role in protecting inland areas from sea water flooding they are regarded as one of the most important components in coastal resilience. Earlier research collaboration with a group of international researchers looked at the role that beach-dune systems and other coastal environments have on coastal protection from an ecosystem services perspective [R3]. Together with researchers from the European Commission’s Joint Research Centre, Delgado-Fernandez mapped and assessed coastal landscapes and their ability to act as buffers against flooding and erosion. This international collaboration involved a Europe-wide assessment, with implications for management around preservation of natural coastlines, sustainability of coastal environments and resilience of coastal communities. Results from this collaboration were featured in the Marine Ecosystem Services Partnership newsletter (3 July 2013), and the Science for Environment Policy newsletter (24 September 2013). Both have strong international scope, with partners such as National Oceanic and Atmospheric Administration and UN Environment Programme-World Conservation Monitoring Centre.

### 3. References to the research

- [R1] Delgado-Fernandez, I., O’Keeffe, N. and Davidson-Arnott, R.G., 2019. Natural and human controls on dune vegetation cover and disturbance. *Science of The Total Environment*, 672, pp.643-656. <https://doi.org/10.1016/j.scitotenv.2019.03.494>
- [R2] Delgado-Fernandez, I., Smyth, T.A., Jackson, D.W., Smith, A.B. and Davidson-Arnott, R.G., 2018. Event-scale dynamics of a parabolic dune and its relevance for mesoscale evolution. *Journal of Geophysical Research: Earth Surface*, 123(11), pp.3084-3100. <https://doi.org/10.1029/2017JF004370>

[R3] Liqueste, C., Zulian, G., Delgado, I., Stips, A. and Maes, J., 2013. Assessment of coastal protection as an ecosystem service in Europe. *Ecological Indicators*, 30, pp.205-217. <https://doi.org/10.1016/j.ecolind.2013.02.013>

[R4] Delgado-Fernandez, I., Davidson-Arnott, R.G. and Hesp, P.A., 2019. Is 're-mobilisation' nature restoration or nature destruction? A commentary. *Journal of Coastal Conservation*, 23(6), pp.1093-1103. <https://doi.org/10.1007/s11852-019-00716-9>

[R5] García-Romero, L., Delgado-Fernández, I., Hesp, P.A., Hernández-Calvento, L., Viera-Pérez, M., Hernández-Cordero, A.I., Cabrera-Gómez, J. and Domínguez-Brito, A.C., 2019. Airflow dynamics, vegetation and aeolian erosive processes in a shadow zone leeward of a resort in an arid transgressive dune system. *Aeolian Research*, 38, pp.48-59. <https://doi.org/10.1016/j.aeolia.2019.03.006>

[R6] García-Romero, L., Delgado-Fernández, I., Hesp, P.A., Hernández-Calvento, L., Hernández-Cordero, A.I. and Viera-Pérez, M., 2019. Biogeomorphological processes in an arid transgressive dunefield as indicators of human impact by urbanization. *Science of the Total Environment*, 650, pp.73-86. <https://doi.org/10.1016/j.scitotenv.2018.08.429>

These papers were all published following rigorous peer review in leading international journals in the areas of geomorphology and coastal studies, environmental science, management and conservation.

#### 4. Details of the impact

##### Changing the perceptions of UK coastal management practice

Delgado-Fernandez's research has contributed to increasing understanding of, and changing attitudes towards, coastal dune processes and evolution, and effecting change to coastal dune management approaches. The impact described here affects the UK and several areas in Spain. Delgado-Fernandez's earlier research focused on understanding dune mobility in vegetated coastal dunes [R2] and the drivers for this [R1], both stemming from a grant funded by Natural England (ECM 6888). Results led to several key management recommendations, including controlling visitor pressure (by for example installing elevated boardwalks and access to beaches) and avoiding direct engineering interventions such as those involving bulldozers artificially stripping dune vegetation.

EHU research outputs coincided with a new Dutch-led approach to coastal dune management to reverse the growth of coastal dune vegetation by excavating plants and soils from dune fields, and that was contrary to our recommendations. The urgent need to disseminate and explain Delgado-Fernandez's results to coastal managers in Britain, and to debate these two very different positions, led to a series of workshops organised at EHU. The 1<sup>st</sup> Coastal Workshop focused on direct discussion of these opposing approaches to coastal dune management. This initiative was received positively from stakeholders, with Natural England's Graham Weaver (Chief Scientist Directorate) reflecting on the need to push for further debate and dissemination on the two conflicting positions [C1]; Katie Finkill-Cooms (Lead Adviser of the Coast and Marine Team in Cheshire, Greater Manchester, Merseyside & Lancashire) found the debate 'enlightening' and pointed to the 'benefits' to her work area; and Dave Mercer (Senior Reserve Manager at Ainsdale) noted the 'level of ignorance experts have of each other's subjects' and pointing to the need to host further workshops to 'broaden perspectives' in the way we had with the 1<sup>st</sup> Coastal Workshop.

Similar reactions were gathered from The National Trust [C2] with Adam Jones and Niel Forbes (Sandscale Haws NNR) citing a 'most thought provoking' event bringing 'different perspectives to the discussion' (Jones) and a great way 'to get alternative points of view regarding dune management'. Representatives of the Sefton Coast Landscape Partnership [C3] found it 'quite sobering' (John Houston, LIFE/HLF project lead) and 'brilliant', 'thought-provoking' and even 'entertaining!' (John Dempsey, Green Sefton).

##### Raising public awareness on coastal management and preservation

The success of the 1<sup>st</sup> Coastal Workshop led to a 2<sup>nd</sup> International Coastal Workshop that brought together new collaborations with Universities in the UK (e.g. Sussex, Brighton) and abroad (Thailand, Spain, Canada, etc.)

(<https://www.edgehill.ac.uk/geography/news/2019/10/31/2nd-international-coastal-workshop/>). This event was open to members of the public and intersected research-management discussions, with integration of physical, economic and social drivers at the

coast. The National Trust's Andrew Brockbank (Countryside Manager) found the conference *'really valuable'* and *'left suitably inspired to really focus on the questions of present and future capacity of coastline'* [C4].

Alongside bringing community members to our University environment, we have engaged with local communities in multiple ways. Electronic material has been hosted by the Coastal Studies Lab co-ordinated by Delgado-Fernandez, and educational resources have been shared with local schools via the Beach Schools Project, led by the Faculty of Education (<https://www.edgehill.ac.uk/news/2019/04/beach-school-enhances-learning-and-teaching-opportunities/>) and currently linked to a new Citizen Science project at the Sefton Coast for which Delgado-Fernandez is PI. We have participated in community knowledge sharing events within the Liverpool City Region (<https://www.edgehill.ac.uk/geography/news/2019/06/24/community-knowledge-sharing-event-within-the-liverpool-city-region/>) and local students have visited our research / experimental sites in the Sefton dunes.

We have been involved in multiple public lectures events (Liverpool, Preston, Southampton) and have shared research findings via BBC North West (12<sup>th</sup> November 2015), where Delgado-Fernandez's appearance to discuss coastal erosion along Sefton Coast was followed by coastal managers from the National Trust at Formby. Examples of the extent to which our research is influencing our local community are Delgado-Fernandez's highly successful presentations for the Southport Scientific Society [C5], with many of these public talks generating *'considerable interest to the extent that more members attend [DF's] lecture than any of our previous presentations'* (January 2020), attracting unusually large audiences (November 2018), and being *'significant'* for members of the public (October 2017). Most importantly, through Delgado-Fernandez's talk, members of the public are *'now able to appreciate the pitfalls that occur when coastal developments take place without an appreciation of the Total Picture'* and that it is only through *'serious research that we can take advantage of our coastal dune systems without causing disasters'* (November 2018).

### **Shaping dune management practices in Spain**

The realisation that the academic debate on coastal dune evolution was having a strong impact on coastal management led Prof Delgado-Fernandez to put together a critical commentary [R4] directed at highlighting the limitations (and potential shortcomings/dangers) of management interventions in coastal dune processes (i.e. large-scale vegetation excavation; something that is currently being conducted in multiple sites in England and Wales as part of the 'Dynamic Dunescapes' project). The discussion has opened an academic debate with implications for management and the role of coastal dunes as a protective buffer against storminess and flooding [R3], with significant international impact. This research has driven significant management decisions at the National Park Bahía de Cádiz [C6] and coastal dunes in Mallorca [C7].

The National Park Bahía de Cádiz contains extraordinary ecological and landscape value and spans over 10,000 hectares, housing over 200 species of aquatic birds. It is made up of an assortment of beaches, marshes, salt flats, intertidal plains, pine forests and tidal streams. Planning decisions at Camposoto beach dunes (coastal section of the park) were informed by Delgado-Fernandez's investigations [C6], with key recommendations such as controlling visitor pressure and installing boardwalks guiding their restoration efforts. The President comments *'Prof Irene Delgado-Fernandez's research on coastal dune evolution and actions to minimize direct human impacts on coastal dunes have wide applicability and supported our planning decisions in the last restoration that we conducted in the dunes of the Camposoto beach'* [C6].

In the Balearic Islands, the Minister for the Environment and Landscape Planning and his team made significant use of Delgado-Fernandez's research to make evidence-based decisions on coastal dune management in Mallorca [C7]. Beach-dune systems in Mallorca attract millions of visitors, with many crossing dune systems and destroying dune vegetation, which in turn leads to increasing coastal vulnerability. The team made use of our research in their planning and conservation efforts, particularly those preventing rejuvenation approaches and enhancing the control of visitor pressure by providing designated pathways.

The Environment and Territory Minister comments, *'The research conducted by Professor Delgado-Fernandez's team is directly related to some of the conservation works we undertake at the coast. By controlling visitors' access to the beach and providing boardwalks and designated paths we remove serious human stressors and allow dunes to evolve naturally. Professor Delgado-Fernandez's research.....contributes to the management decisions we make and allow us to base our decision making on robust scientific knowledge'* [C7].

Recently, Delgado-Fernandez's research has led to significant changes and actions taken at the largest coastal dune field site in the Balearic Islands: the Parc Natural d'Es Trec-Salbolar de Campos in Mallorca [C8]. This is a site of rich biodiversity including natural environments whose conservation is legislated by international regulations such as the EU Habitats Directive and other Balearic and Spanish laws. Recent debates by Delgado-Fernandez [R4 in particular, but also supported by R3 and R1] have led to changes to management in favour of controlling human impacts and recreational visitor pressure. The President of the park notes that the balance of debate between human interest and park preservation has been aided by the research and evidence based decisions on management have been made easier: *'Current on-going debates on how coastal dunes should be managed sometimes can add to the pressure of making appropriate decisions at the Park level. The research conducted by Prof Delgado-Fernandez and her team has been key to inform the conservation activities we conduct and plan at the Park'* [C8].

Recommendations by Delgado-Fernandez and colleagues have led to multiple benefits at one of the most significant arid coastal dune fields in Europe: the Maspalomas dune field (Gran Canaria). Here, Delgado-Fernandez's site-specific research [R5, R6] and international background led to an invitation by the Gran Canaria Government (Cabildo) to act as a coastal expert in their MASDUNAS Project (<https://masdunas.es/wp-content/uploads/2019/04/Tr%C3%ADptico-English-MASDUNAS-DINA4.pdf>). The project was the first of its kind and aimed at restoring the Maspalomas dune field, a valuable ecosystem and international tourist hotspot, and hence a landscape hosting conflicting uses as a nature reserve, recreational area and socio-economic motor of the island. Delgado-Fernandez was part of the first series of workshops involving several national and international coastal dune experts. A series of recommendations were made following the workshop and site visits [C9], which were adopted by project leads and were applied as part of the management of the dune field *'...her research on human impacts on coastal dunes had direct benefits for landscape planning, including the installation of networks of trails to control visitors pressure in the dune field'* [C10]. The research led to televised appearances including the national news for Televisión Canaria, the most important TV channel in the Canary Islands and the one with the largest audience. The channel openly recommended our paper [R6] in their programme of the 30<sup>th</sup> January 2019 [C11] (relevant content 28:42 minutes into the broadcast).

##### 5. Sources to corroborate the impact (indicative maximum of 10 references)

- (C1) Natural England testimonials
- (C2) National Trust testimonials
- (C3) Sefton Coast Landscape Partnership testimonials
- (C4) National Trust testimonial
- (C5) Southport Scientific Society testimonial
- (C6) Natural Park of Bahía de Cádiz testimonial
- (C7) Balearic Islands Government testimonial
- (C8) Parc d'Es Trec-Salbolar testimonial
- (C9) Gran Canaria Government, Masdunas project report [English translation at end]
- (C10) Cabildo de Gran Canaria testimonial
- (C11) Canary Islands TV showing - <https://www.youtube.com/watch?v=ISFpPPpXxug&feature=youtu.be>