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Can coastal gravel-dominated coastal barriers show persistent resilient morphological tuning to extreme storms?

Julian Orford (1), Loraine Barry (1), and Tim Collins (2)

(1) Queen's University, Belfast, School of Natural and Built Environment, Belfast, United Kingdom (j.orford@qub.ac.uk), (2) Natural England, Peterborough, United Kingdom

The issue of whether coastal gravel-dominate barriers (GDB) are 'tuned' to extreme storms is considered in terms of upper barrier architecture changes on a North Norfolk (UK) GDB (Cley/Salthouse barrier) relative to a series of extreme North Sea coastal storms. Tuning is measured in terms of morphological change to the upper barrier beach, barrier crest and back-barrier, whereby the GDB's physical vulnerability is a function of a barrier's morphological resilience (R) under extreme storm-generated overwash assisted by elevated tide and surge. Resilience is a GBD system's morpho-dynamic capacity to ensure stressors and shocks of extreme event conditions do not have long-lasting adverse consequences (i.e. barrier breakdown), but rather ensure barrier rollover showing a potential equilibrium cross-barrier profile underlying barrier resilience. This process: 1) assumes that only extreme events drive GDB change; 2) is concerned with macro morph space-time changes; 3) is not concerned with why overwash occurs per se at any point, but rather how does whole barrier respond to range of overwashing; 4) is there an equilibrium barrier profile that evolves; and 5) is there a time dimension to changing trajectory of upper barrier alteration (defining a resilience trajectory)? Cley/Salthouse GDB is c 11km long and comprises an updrift managed barrier (6km) and downdrift natural barrier (5km). Management undertook to reprofile the barrier crest after storm action. After 2006 reprofiling ceased and the barrier was left to evolve naturally. Ten LiDAR covers between 2000 and 2014 show barrier changes related to four extreme storm events in which the barrier was variably longshore overtopped and over washed. LiDAR analysis allowed 32 cross barrier profiles 200m apart (from MHWS to back-barrier edge) to be serially measured (261 profiles) for calculation of 16 morphological indices. These are used to characterise the changing upper barrier architecture of both natural and ex-managed profiles. Use of PCA reduces cross-profile variation to 3 orthogonal components interpreted as Barrier Morphology (50%), Barrier Cross-beach Position (30%) and Back-barrier Edge Elevation (10%). Cluster Analysis based on component scores derives 5 cross-barrier profile Types. Over the four extreme events, profile change can be characterised as reflecting: i) natural functioning barrier profiles 'tuned' to extreme events (Resilience achieved: types 4&5); ii) Barrier profile transition (Developing Resilience: types 1&2); and iii) Temporary Hiatus in Resilience attainment (type 3). Time/Space changes of profile Types triggered by storms, shows an evolution to resilient cross-barrier profiles (Types 4 and 5) from developing resilience (Types 1&2) with 15% to 65% occurrence of 'tuned' profiles between 2000 – 2014. A further aspect of tuning is the associated spatial component of swash-aligned barrier retreat due to RSL rise, however attainment of swash-alignment is blocked by the longshore persistence of Profile Types 1-3. In conclusion, barrier tuning (i.e. resilience) is shown to occur under extreme coastal surge events driving crest overwash. Barrier tuning will assist maintenance of cross-barrier morphology and sediment volume. Barrier inertia (due to management re-profiling) can prevent tuning occurring, but is usually a short-term delay dependent on extreme event occurrence.