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Geomorphometry in coastal morphodynamics

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Geomorphometry is a cross-cutting discipline that has interwoven itself into multiple research themes due to its ability to encompass topographic quantification on many fronts. Its operational focus is largely defined as the extraction of land-surface parameters and earth surface characterisation. In particular, the coastal sciences have been enriched by the use of digital terrain production techniques both on land and in the nearshore/marine area. Numerous examples exist in which the utilisation of field instrumentation (e.g. LIDAR, GPS, Terrestrial Laser Scanning, multi-beam echo-sounders) are used for surface sampling and development of Digital Terrain Models, monitoring topographic change and creation of nearshore bathymetry, and have become central elements in modern investigations of coastal morphodynamics.

The coastal zone is a highly dynamic system that embraces variable and at times, inter-related environments (sand dunes, sandy beaches, shoreline and nearshore) all of which require accurate and integrated monitoring. Although coastal studies can be widely diverse (with interconnected links to other related disciplines such as geology or biology), the characterisation of the landforms (coastal geomorphology) and associated processes (morphodynamics, hydrodynamics, aeolian processes) is perhaps where geomorphometry (topo-bathymetry quantification) is best highlighted. In this respect, many tools have been developed (or improved upon) for the acquisition of topographic data that now commands a high degree of accuracy, simplicity, and ultimately acquisition cost reduction.

We present a series of field data acquisitions examples that have produced land surface characterisation using a range of techniques including traditional GPS surveys to more recent Terrestrial Laser Scanning and airborne LIDAR. These have been conducted within beach and dune environments and have helped describe erosion and depositional processes driven by wind and wave energy (high-energy events). Other examples include long-term monitoring of beach dynamics and evolution, examining the impact of natural hazards (surges, storms, sea-level rise) on coastal areas using GPS-linked drones to acquire repeat topographic (point clouds) surveys over inter-tidal and dune edge/back beach zones. Nearshore 3D bathymetric information generated from navigation charts, echo-sonar instruments or more recently from Satellite (LANDSAT) imagery is also highlighted as a key dataset in geomorphometry.

The recent technological developments in 3D data acquisition within the coastal and marine environment now offers exciting opportunities in which to reveal how these systems function across multiple time and space scales. Whilst this can offer new insights, it also presents significant analytical challenges due to the sheer volume of data generated, the necessity of specialist personnel and software to process the data. Geomorphometry can help play a key role in this progression and take analysis within coastal science to new levels.