Remote sensing and coastal geomorphology

New techniques for monitoring short-term changes

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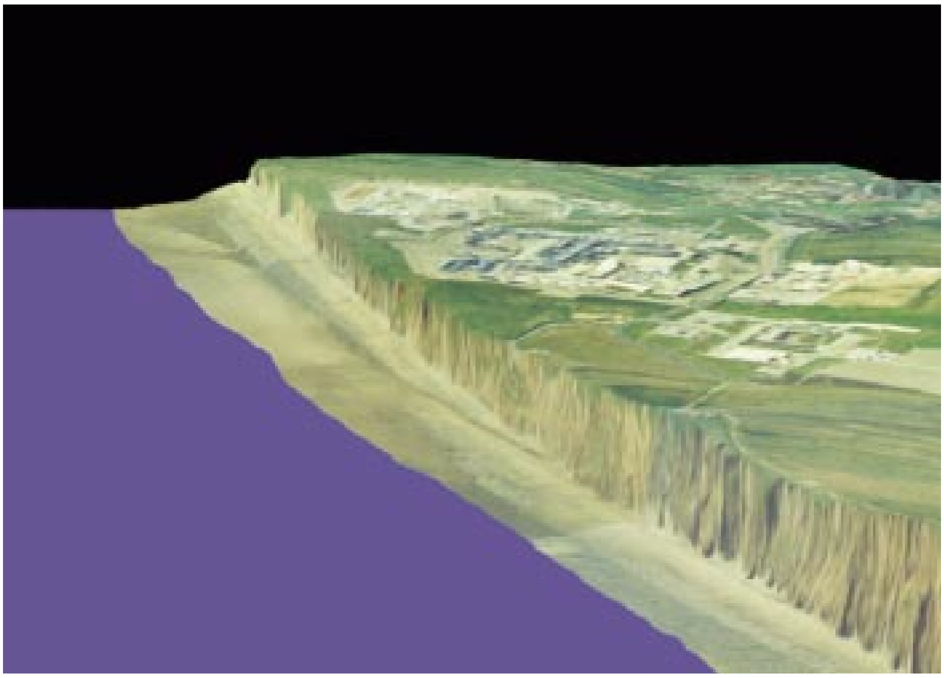
Due to the dynamic nature of coastal and estuarine environments, the quantitative assessment of sediment erosion and deposition by traditional ground-based surveying techniques has been both difficult and time-consuming. Beach profiles may be spaced hundreds of metres apart and long coastal profiles or large estuarine mudflats with limited exposure due to the tides, make it impossible to get a realistic snapshot in time of the geomorphology. Continuous and near instantaneous measurements over large areas, are required with a high degree of vertical and spatial accuracy. Two airborne techniques, digital photogrammetry and laser altimetry, provide such measurements.

Large scale aerial photography (1:3000 to 1:6000) combined with digital photogrammetry, has the potential to solve some of these problems. A 50 km length of coastline can be photographed in about 12 minutes. Given good ground control (2-3 cm accuracy) and optimum conditions, the best height accuracy expected from aerial photography is about 9 cm at 1:6000 scale. However using relative Global Positioning System (GPS) ground control points with 2-5 cm vertical and horizontal accuracies, and automated techniques of digital photogrammetric height extraction using an Intergraph ImageStation, the BGS has found that vertical accuracies are about 25 cm for 1:6000 photography. This figure applies only to well-textured parts of the photographic image.

A promising new airborne technique which is particularly suitable for coastal and estuarine environments, is LIDAR (Light Detection And Ranging). This uses a laser altimetry system to measure the distance from the sensor to the Earth's surface precisely. When combined with GPS and Inertial Navigation Systems to accurately determine the sensor's position and orientation, it can provide high precision elevation data to 10 – 20 cm vertical accuracy. At a nominal flying altitude of 1000 m (about 1:6500 scale), and depending on the wavelengths and frequencies used, the laser forms a beam approximately 20 cm in diameter, with the beams spaced 1-3 m apart, and forming a swath width of about 250 m. Depending on which LIDAR system is used, the average area covered by each data measurement varies from 0.2 m^2 to 6 m^2. LIDAR offers some advantages over the photogrammetric method in that data can be obtained in poor light conditions and can even be obtained at night. There is less reliance and expenditure on expert interpretation and there are none of the problems caused by featureless surfaces.

When linked to geological and oceanographic data the terrain models produced using these methods can be used to investigate the extent, nature and volumes of coastal sediments and to assess the susceptibility of coastal lowlands to tidal flooding. When combined with other field measurements or with repeat surveys, short-term temporal changes in coastal geomorphology due to sediment erosion or accretion can be determined and sediment budgets quantified. These products are an essential part of any sustainable coastal management strategy.



Perspective view (looking south) of a digital terrain model (DTM) created using digital photogammetry draped with a 2D orthophoto of the Holderness cliffs at Easington,Yorkshire.