GPS verification of National Mapping Agency topographical data for generation of high-accuracy GPS-derived topographic model data for sea-level rise prediction in protected salt marsh areas.

Seamus Coveney[1], Stewart Fotheringham[2], Martin Charlton[3], John Sweeney[4]

[1]National Centre for Geocomputation NUIM, Ireland & Department of Geography, NUIM, Ireland.
Telephone: (00353-1-7086196)
Fax: (00353-1-7086456)
Email: seamus.j.coveney@nuim.ie
[2 & 3] National Centre for Geocomputation NUIM, Ireland.
[4] Department of Geography, NUIM, Ireland.

Global average temperatures have increased by approximately 0.6°C during the 20th century, and are projected to increase by a minimum additional 1.4 °C by 2100. The relationship between atmospheric warming and sea-level rise (SLR) is well documented, and is expected to lead to SLR of up to 0.8m by 2100 (IPCC, 2007). Estuaries are predominantly sedimentary environments, and are characterised by shallow sloping gradients, making them particularly sensitive to SLR. The Shannon estuary is the largest river estuary in Ireland and is designated as a Special Area of Conservation, providing legislative protection for a range of habitat types, including estuarine salt marsh (E.U., 1992).

This paper discusses the development of methods for enhancing the accuracy of SLR predictions in the estuary up to 2100, with a particular focus on generating accurate predictions for salt marsh areas. Historical tidal records are frequently used to assess generalised regional sea-level trends (Woodworth *et al.*, 1999). SLR is caused by eustatic change (rising water level) and isostatic change (land surface crustal movements). Ireland is experiencing both eustatic and isostatic changes. The major force for eustatic change is climate change, while the source of isostatic change is post-glacial crustal rebound. Post-glacial rebound in the north of Ireland is leading to compensatory downward crustal movements further south, providing an additional input to SLR in the south of Ireland. The specific proportional contributions of eustatic and isostatic forces are not as important as their combined impact on SLR trends. Twice-daily high-tide data from Limerick dock (15km from the project study area) suggests SLR of 4.0 - 4.5mm/yr for the period from 1877 - 2004. This trend is approximately 2.5 times greater than the observed global average SLR trend since the Industrial Revolution. This suggests that SLR in the Shannon estuary over the next century may be significantly larger than global predictions from the IPCC.

The generation of meaningful SLR predictions presupposes the existence of accurate topographical data. National mapping agency Digital Elevation Model (DEM) data for Ireland is characterised by vertical errors of ±3m, suggesting that it is unsuitable for use in SLR modelling. High-accuracy Aerial Laser Scanning (LIDAR) data is generally preferred for SLR modelling, but LIDAR surveys for Ireland have not yet extended to include most of the western seaboard (including the Shannon estuary). While the quality of the OSi DEM suggests that it is not suitable for direct SLR modelling, it may be the case that errors in this dataset are lower at the coast. DEM are often related to topographic complexity, suggesting that flat coastal areas may be subject to DEM errors (Holmes *et al.*, 2000).

RTK and post-processed survey grade GPS, plus Terrestrial Laser scanning (TLS) surveys were carried out across a number of adjacent salt marsh areas in the estuary to evaluate error ranges in the National DEM dataset, and to provide the basis for a new high-quality local DEM for SLR modelling in the Shannon estuary study area. Errors in the OSi DEM were found to be within published ranges, with the largest errors occurring towards the coastline (i.e. the theoretical zero contour). This confirmed the unsuitability of the OSi data for use as the basis of indicative SLR modelling. The accuracy of the GPS survey data was validated against external GPS reference stations, confirming the average accuracy of the 600-point GPS survey dataset to between 1 and 2cm. vertical errors within in the TLS data were within the 1 – 2cm range also, suggesting that the GPS and TLS datasets could indeed be used to generate a local DEM of quality sufficient for meaningful SLR prediction.

The survey-derived DEM data is now being used to accurately define SLR risk in the study area, and the DEM data is being used in conjunction with local erosion and deposition data and coastal morphology models to predict specific risks within protected salt marsh within the study area.

References

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