Identifying coastal archaeology using multispectral satellite imagery of the intertidal zone: A pilot study

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This English Heritage funded project explored the use of multispectral satellite imagery for archaeological investigations in the intertidal zone. As a pilot project, the study focused on the well documented Portsmouth and Langstone Harbours. The aim of the study was to examine the potential of multispectral surveying techniques in the monitoring and management of intertidal cultural heritage. The rationale for the successful use of multispectral imagery in the identification of sub-surface archaeology is based on previous studies of terrestrial archaeology in Scandinavia (e.g. Grøn *et al*., 2011), where expert interpretation of QuickBird and Ikonos imagery was capable of identifying features as small as cooking pits and post holes within agricultural landscapes. To date, there has been limited investigation of intertidal archaeology using satellite imagery, and hence this study provides a first look - pilot study - evaluation of the potential of this new approach.

QuickBird imagery comprises four multispectral (blue [λ = 450-520 nm], green [λ = 520-600 nm], red [λ = 630-690 nm] and near infrared [λ = 760-900 nm]) and one panchromatic (black and white [λ = 450-900 nm]) bands: pixel resolution is 2.44m and 0.61m in the multispectral and panchromatic bands respectively. Images covering the full tidal zone and local coastal margins of both Portsmouth and Langstone Harbours, was first analysed to examine the spectral signatures of known (registered) archaeological sites. Individual bands were reviewed, in addition to a series of band-ratios and multivariate statistics. Second, the same images and methods were used to identify spatial anomalies which had the potential to represent other, unknown (unregistered) archaeological features. The research relied on the strong supporting knowledge-base of known archaeological sites and other anthropogenic features within and adjacent to Portsmouth and Langstone Harbours. The research also drew from a wide range of spatial datasets, describing the archaeology and geomorphology of the region of interest in detail.

The results of the study were rather mixed, and showed that archaeological features are variably visible within multispectral imagery. Existing sites (both registered archaeological features and anthropogenic elements) were more likely visible in the multispectral imagery if they had a broad spatial extent, and it was clear that in many cases the spatial resolution of QuickBird imagery was too coarse to detect features, particularly smaller expressions such as posts and hearths. High resolution aerial photography (recent acquisitions achieve 0.2m pixel resolution) was more successful in representing features of small extent, but clear surface presence. On the whole, larger features were more successfully detected within the QuickBird imagery, but where the features were formed in a degraded material such as wood, the lack of coherent spatial expression precluded identification within the multispectral imagery. A calibration analysis was not possible due to the insufficient number and variation of registered features detectable in the QuickBird imagery. Although often a useful addition to high resolution aerial photography, QuickBird could not be used in isolation for archaeological surveys of intertidal zones.

The wider exploration of the multispectral images for all spectral anomalies produced a number of interesting results suggesting that QuickBird imagery had some potential in terms of initial exploratory investigations. A number of unexplained anomalies were found in the multispectral imagery and many of these were indicative (in terms of size, shape and location) of subsurface wrecks. The near-infrared band in particular was very effective at identifying features that were not visible in even the high resolution aerial photography. Again size and location were important factors in the clarity of the anomaly. First, large anomalies with a consistent spectral signature are confidently differentiated from the surrounding substrate, even where textural differences produce a noisy reflectance. Second, anomalies located on the main intertidal flats are more distinct than those occurring in the upper foreshore or along the littoral shoreline, where noisy spectral characteristics make interpretations difficult.

Multispectral imagery may have a potential role in intertidal archaeology, but further research is needed to:

a) progress a more substantial investigation of registered features of specific types, where a large number of existing hearths, wood objects, flint remains can be assessed to help derive a more rigorous analytical process;

b) undertake a field campaign to examine the anomalies identified in the imagery to either validate the presence of archaeological features or inform the anomaly identification process.

References

Grøn, O., Palmer, S., Stylegar, F.-A., Esbensen, K., Kucheryavski, S., & Aase, S. 2011 Interpretation of archaeological small-scale features in spectral images. *Journal of Archaeological Science*, doi:10.1016/j.jas.2009.11.023.