Brightlingsea Harbour, UK, Dredging and Restoration Programme: Using Sediment As a Resource (USAR)

William Coulet[1], Will Manning[1]

[1]Exo Environmental Ltd., Enterprise Centre, University of East Anglia, Norwich, UK. Phone: +44-(0)-3308-080377
E-mail: william@exo-env.co.uk

Introduction: Brightlingsea Harbour, UK, is subject to the natural deposition of sediment. This sediment is now causing significant concern to Brightlingsea Harbour Commissioners (BHC), the managing authority of this historic harbour. In order to maintain the safe and efficient operation of the harbour, the removal of approximately 53,000m^3 of accumulated sediments is required.

As part of the Interreg 2 Seas programme, "Using Sediment As a Resource (USAR)", this sediment will be dredged over four consecutive winters (October – March, 2016-2020) and beneficially reused to restore a total of 5ha of protected intertidal mudflat and saltmarsh. Whilst newly restored habitat will protect and improve the structural integrity of the local coastal flood defences, the habitats themselves play an important coastal flood defence role.

For example, saltmarsh has been shown to result in a reduction of energy equivalent to a reduction in wave height during storm surge conditions of approximately 20% [1]. The natural attenuation of wave energy also provides associated cost savings for man-made coastal flood defences, with an 80m wide strip of saltmarsh saving an estimated £400$^{(1995)}$ per linear metre of a 3m high crest seawall [2]. Due to the ability of saltmarsh to 'grow' vertically through sediment accretion, they also offer resilience in the face of predicted sea level rise [3].

Methods [4]: Environmental surveys provided oceanographic, atmospheric, bathymetric and physical and chemical characterisation of the site. This allowed Exo Environmental to carry out a valorisation of the dredged sediment, through a series of cost – benefit analyses. The data was also utilised to develop a 2D hydrological and geomorphological predictive model. Using this information, a dredging plan was formulated including location of dredging, target water depth and dredging method.

The restoration sites were established through the comparison of historical aerial photographs from 1946 & 1953 with satellite imagery from 2006. It identified areas of habitat loss, degradation and the potential for restoration.

Restoration sites were selected based on the dredging plan and environmental conditions, and those areas highlighted as suffering historic loss of saltmarsh. The process was carried out in conjunction with many local stakeholders and representative groups, including wildlife, fisheries, recreational and commercial focussed organisations.

The design of the restoration sites involves structures that retain the dredged clayey silt and silty clay, and ensures it does not slump back into the newly dredged navigation channels. The retaining structures are based on natural and sustainably sourced materials. These include brushwood fascines comprised of locally sourced pine posts and hazel brushwood. A new oyster reef created using locally sourced oyster shell stored within gabion baskets. European hemp is being utilised in conjunction with straw bales to ensure the containment of sediment in compartments where required.

In addition to habitat restoration, some sediment will be used to create GeoBlock prototypes. GeoBlock is an innovative, geo-engineered cuboid that uses dredged sediment as the primary aggregate and is stabilised using a site specific mixture of binders. The GeoBlock will be placed in locations with higher wave energy, as erosion control application.

Results: Initial dredging operations began in November 2016 as per the dredging plan. Further dredging and restoration works will commence mid January 2017 due to mitigation measures.

Discussion:

Beneficial reuse of sediment in intertidal marshes is not only important for wildlife and to restore natural balance, the additional benefit of coastal defences should not be underestimated.

In conjunction with the University of East Anglia and the University of Essex, Exo Environmental will, in addition to ongoing project monitoring, conduct studies investigating the impact of beneficial reuse on subjects including, but not limited to; ecosystem services, biogeochemistry and vertical migration.

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References: [1] Möller et al. (2014) *Nature Geoscience* **7**:727-731; [2] Toft et al. (1995) National Rivers Authority **324**:123; [3] Haslett et al. (2001) Estuarine, Coastal and Shelf Science **52**:143-153, [4] PIANC Working with Nature (2017).