



Highlights in this issue:

- The Challenge of modelling decadal coastal morphology
- Integrating environmental modelling using FluidEarth
- Coastal Systems Mapping
- Site Visits and Stakeholder Workshops

Contact

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WELCOME

Welcome to the first twice yearly newsletter for the iCOASST project. These newsletters will:

- Provide a regular update on the project research and outcomes.
- Communicate with a wide range of interested parties.
- Encourage a wider discussion and debate about the iCOASST project

What is the iCOASST Project?

The aim of this project is to improve our capability to predict decadal (10 to 100 year) scale erosion and accretion around the coast and estuaries of the UK and hence, enhance erosion and flood risk management.

This 4 year project, running from 2012 to 2016, is funded by the National Environmental Research Council (NERC) with the support of the Environment Agency. The consortium, led by Professor Robert

Nicholls at the University of Southampton, brings together a number of the leading UK universities, research laboratories and consultants in the fields of geomorphology, engineering, oceanography and software development. They are developing and integrating several distinct approaches to achieve the aim. More details can be found in Nicholls et al (2012), at www.coasst.net and in this newsletter.

Who will benefit from the project?

The main beneficiary of knowledge arising from this research will be Local Authorities and the Environment Agency (EA) in England and equivalent bodies around the UK, who deliver flood and coastal erosion risk management. Other beneficiaries include the Department for Environment, Food and Rural Affairs (DEFRA - UK Government), specialist consultants who undertake the Shoreline Management Plans (SMPs) and Strategy Studies, local stakeholders (including community groups, commercial concerns and the general public) and the national and international research communities.

Nicholls et al. (2012) iCOASST - integrating coastal sediment systems. In, Proceedings of ICCE2012 International Conference on Coastal Engineering, Santander, Available at <http://www.icoasst.net/Outputs/Publications/>

Project Partners

UNIVERSITY OF
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**National
Oceanography Centre**

NATURAL ENVIRONMENT RESEARCH COUNCIL



**British
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Project Lead:

University of Southampton

Subcontractors:

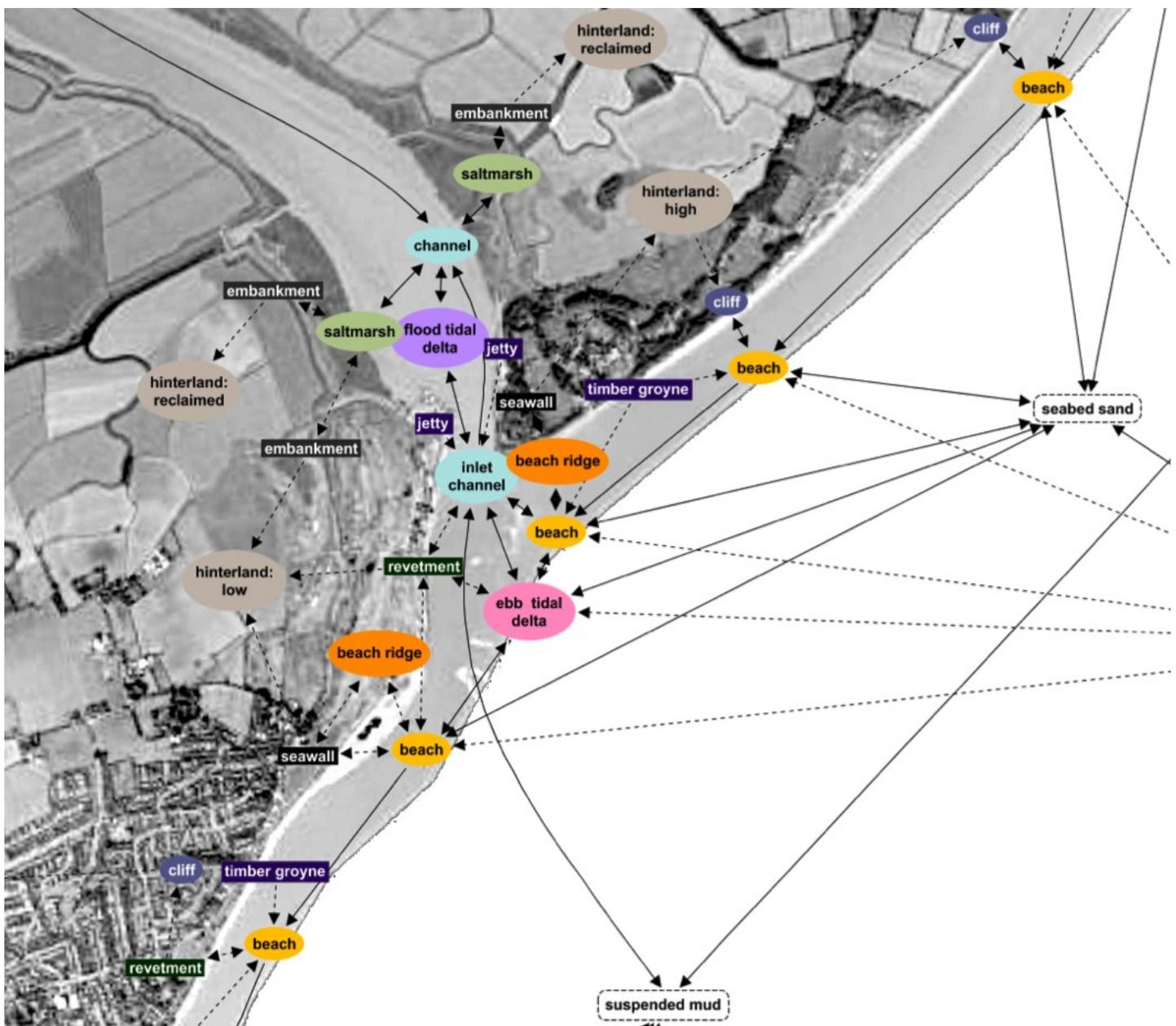
University of Liverpool
Cardiff University
Channel Coast Observatory
Royal Haskoning DHV

Mapping the structure of coupled coast and estuary geomorphological systems

Jon French and Helene Burningham (UCL)

One of the early activities within the iCOASST project has been to develop a new overarching conceptual framework that helps us to understand the complex web of interactions that govern coastal and estuarine morphological change at timescales of decades to centuries. Led by UCL, this work provides more detail than previous mapping of coastal cells and sub-cells in England and Wales and also incorporates the enormous variety of human interventions that constrain present and future coastal evolution. A key goal is to properly integrate the treatment of open coasts with estuaries – which have traditionally been considered largely in isolation – and also the inner part of the coastal shelf, with its bank systems and sediment stores. At the heart of this approach is an ‘ontology’ - a classification and associated rules – that defines a spatial hierarchy of coastal regions, landform complexes and individual landforms, as well as a comprehensive set of engineering structures and other non-structural interventions (e.g. dredging). We have also developed software that works within

the Quantum Geographical Information System (QGIS) to interactively define landforms, interventions and the interactions between them on top of a base map. This allows users to produce visualisations that are effective as a catalyst for structured discussions and for stakeholder engagement with geomorphic system behaviour and its implications for climate change impacts and their management. The process also combines diverse sources of information (scientific research, consultant reports, local opinion, data etc) into usable knowledge. In digital form, they also store quantitative data and model results, including estimates of the major sediment transfer pathways that can then be used to define a sediment budget. Pilot maps have been produced for demonstration regions in Liverpool Bay and Suffolk, prior to an analysis extending to the whole of England and Wales. The software, which is fully open-source, will be available as a free download once internal project testing has been completed.



Illustrative application of software to mapping of estuary-coast interaction in Suffolk.

The Challenge of Modelling Decadal Coastal Morphology Changes and the iCOASST Formal Approach

Andres Payo & Jim Hall (University of Oxford)

The iCOASST aim: to improve our capability to predict decadal (10 to 100 year) scale coastal erosion and accretion to support coastal management is a challenge because the problem is neither well understood nor expressed. Hence, as a first step a formal problem structuring method is needed which includes effective communication between different expertise and interests (e.g. the manager, the coastal expert, the modeller). The iCOASST framework provides modellers with a guide for decision making during the model development and a roadmap for stakeholders from the problem situation to a set of solutions.

The RoadMap from Problem to Solution

Computer models are widely used to assess the influence of human interventions on coastal geomorphology changes and responses, although key steps are often missing. The iCOASST framework explicitly defines a series of steps included the key development and validation activities that are needed in the development and use of a realistic computer model of coastal geomorphic systems (Figure 1).

The four development activities are: (1) knowledge acquisition, (2) quantitative modelling (which integrates conceptual modelling, prototyping and model coding), (3) experimentation and (4) implementation. The outcome of each activity is: (1) a system description, (2) a quantitative model, (3) solutions to the problem situation and/or a better understanding of the real world, and (4) solutions of the problem. The three validation activities are: structural, behavioural and policy validity testing. The outcome of each validation activity is an increase/decrease in the confidence in the computer model in terms of scope and level of detail, behaviour and implications for policy, respectively. The double arrows in Figure 1 illustrate the iterative nature of the activities and the circular flow of these four main activities illustrates the potential for multiple cycles of development. Most of the efforts during the first year of iCOASST have been focussed on the system description activities: stakeholder meetings (problem situation), data gathering, coastal system mapping and causal loops diagrams. The latter two issues are discussed here.

Coastal System Maps and Causal Loops Diagrams

We define validation as the process of establishing confidence in the robustness (i.e. the representation of the problem) and usefulness (i.e. simulations address the strategic, tactical and general modelling objectives) of a simulation model. Although the validation process is iterative, the essence of a simulation model lies in how well the problem has been conceptualized and causal relationships are identified, or how the conceptual model is constructed. In iCOASST, Coastal System Mapping (CSM) and Causal Loops Diagrams (CLD) are being explored as knowledge formalization tools to ensure that the system description is appropriate.

Coastal System Mapping is a new approach to the conceptualisation of large-scale coastal geomorphic systems based on a hierarchical classification of component landforms, management interventions and mapping of the interactions between them (see page 2 of the newsletter, and French et al., 2010). The use of CSM can enhance the coastal cell/sub-cell approach currently used in shoreline management planning and provide a transparent evidence-based framework for more quantitative modelling.

The use of Causal Loop Diagrams overcomes the limitations of the simplifying assumption that morphology changes are caused by a forcing acting at similar space and time scale to observed changes, and more importantly the lack of an accepted formal description of the geomorphic behaviour of the coastal system. In a comprehensive review, Payo et al. (2013) has shown how CLD can be

used to unambiguously represent our current understanding of coastal system dynamic avoiding the conundrums of numerical modelling. They have also shown how the coastal system behaviour can be captured by a reduced set of variables and its interactions. The combination of CSM and CLD provides a formal and broadly applicable framework for more quantitative modelling in the iCOASST Project.

French et al. (2010). Coastal system mapping: a new approach to formalising and conceptualising the connectivity of large-scale coastal systems. Proceedings American Geophysical Union.

Payo et al., (2013). A review of time and space causality in coastal geomorphology as a conceptual framework for modelling decadal to secular evolution. Geomorphology (in-progress).

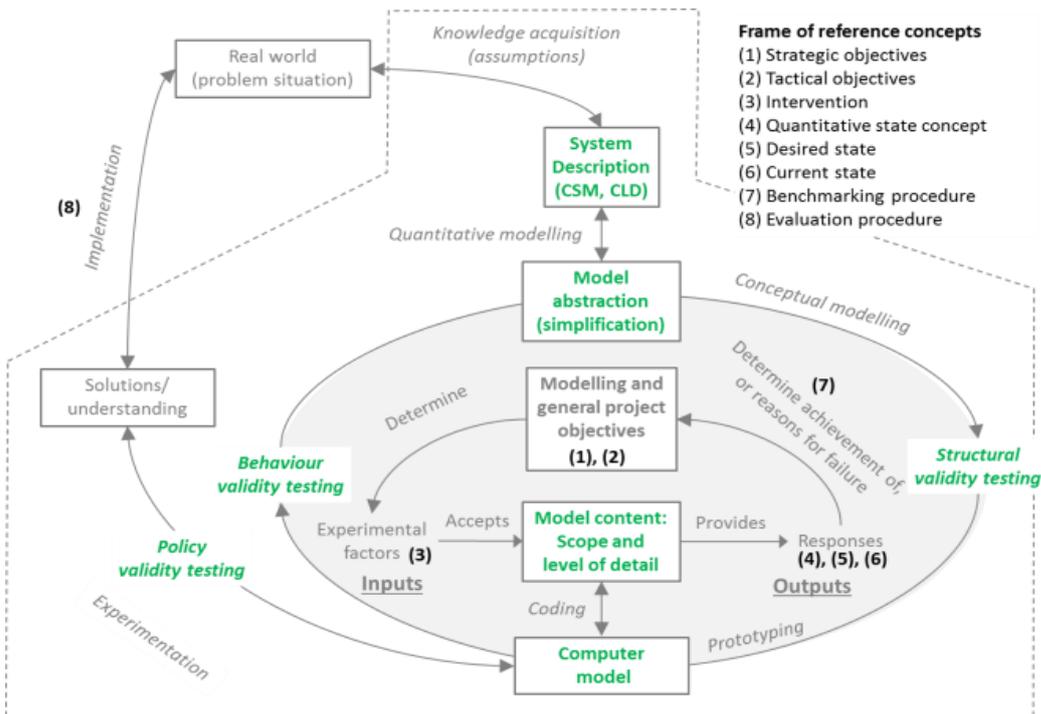


Figure 1. The roadmap from problem situation to solutions. iCOASST operates in the space within the dashed line.

Integrated Environmental Modelling using FluidEarth

J. Sutherland, R.J.S. Whitehouse (HR Wallingford)

There is a growing awareness of the need to model environmental systems as a whole. For example, 'whole catchment modelling' is required to deliver the objectives of the Water Framework Directive, while the aims of the Integrating Coastal Sediment Systems (iCOASST) project requires the modelling of different interacting coastal environments. The drive to model systems in the environmental sciences has led to the development of different supporting computer architectures. Integrated environmental modelling can be undertaken by building a 'super-model' simulating many processes or by using a generic coupling framework to dynamically link distinct separate models during run-time. Our approach to dynamic linking is to adopt the Open Modelling Interface (OpenMI).

OpenMI (www.openmi.org) is a software component interface standard for numerical models that allows two-way exchange of data between compliant components as they run. A composition is formed when OpenMI compliant components are linked and run together, exchanging data as they run. Although OpenMI was originally conceived to facilitate whole-catchment modelling, it is a generic solution to the problem of data exchange between models or software components. The generality was extended with the release of version 2.0 of the OpenMI Standard which added base interfaces, extensions and adaptors (between the output of one model and the input of another).

The creation of an open modelling environment capitalises on the huge prior investment in model development, to ensure that the vast amount of encapsulated knowledge in existing (proprietary) tools was not abandoned, but rather was modernised, re-cycled and re-used.

iCOASST is using HR Wallingford's FluidEarth 2.0, which is the Windows (.Net 4) reference implementation of the OpenMI 2.0 standard. The FluidEarth software development kit (SDK) has been designed to make it relatively easy to make models (and other components) OpenMI compliant, while the GUI (known as Pipistrelle) provides a user-friendly interface to allow users to assemble and run compositions of models (Figure 1, Sutherland et al, 2013).

Pipistrelle and the FluidEarth 2.0 SDK are open source and can be obtained from <http://sourceforge.net/projects/fluidearth> while a set of examples that use models and adaptors are provided at <http://eLearning.fluidearth.net>. The FluidEarth por-

tal, <http://fluidearth.net>, has news, links, a discussion forum, case studies and community contact details as well as a catalogue.

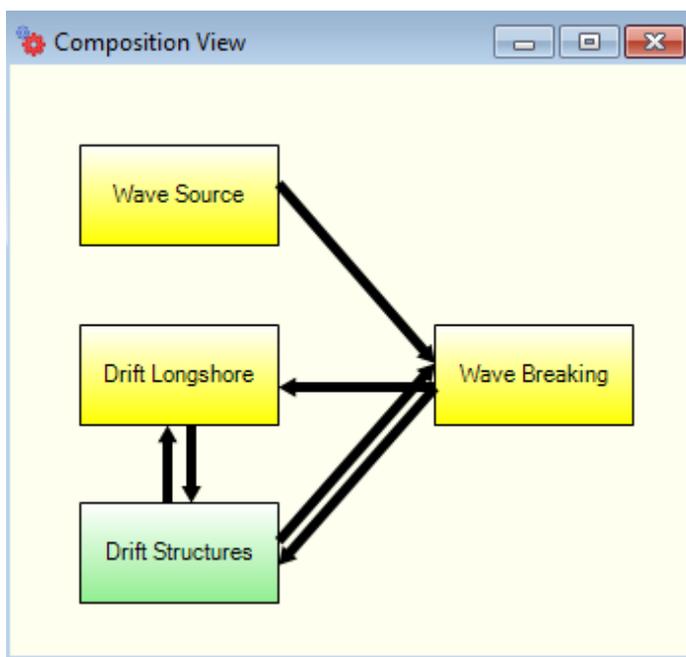


Figure 1 Pipistrelle GUI showing a beach plan-shape composition of four components with two sets of bi-directional links and two uni-directional links

Sutherland J, Bolster M and Harper A, 2013. Beachplan as an OpenMI composition. *Proceedings of the 35th IAHR World Congress, Chengdu, China.*

iCOASST visit to the Sefton Coast – part of the Liverpool Bay case study.

Jenny Brown (National Oceanography Centre, Liverpool)

July 3rd 2013 was bright and breezy, just right for the iCOASST team to visit the Sefton Coast. Lead by Graham Lymbery and Paul Wisse (Sefton Metropolitan Borough Council) the team were guided around the geomorphic features, to learn about the management issues that this coastline faces. The tour started at Crosby Baths where dunes have now developed in front of the hard defences. Continuing north along the coast the defences changed from the rock armour to rubble beach before reaching the River Alt and its training walls. Walking along the retreating dune frontage at Formby Point the group saw the exposed nicotine waste and searched for ancient foot prints in the mud outcrops on the beach. The management issues here were related to the re-exposure of a buried car park and the present threat to a caravan site. Passing through the National Trust site the group were lucky enough to spot a red squirrel. A final stop at Southport pier was the perfect place to get a feel for the extent of land reclamation in the area and view the influence from the Ribble Estuary. In contrast to the retreating dune system, extensive saltmarsh accretion has occurred from the Ribble north of the pier and a green beach at Birkdale has formed to the south.

The informal setting of the tour allowed the iCOASST team to meet the local stakeholder community, while gaining an appreciation for the extent of this coastal system, the historical human influence and the present management issues. A great day out was had!



Many thanks to Sefton Metropolitan Borough Council for their time and input to the hosting the project team.

iCOASST visit to the Suffolk Coast

Helene Burningham (UCL)

The iCOASST team braved an arctic wind in March 2013 to visit the Suffolk coast. Although an area which was well known to some of the team, it was the first visit to Suffolk for many. We made several stops during the day to see some classic coastal geomorphology and a wide range of coastal management interventions, and to understand more about the dynamics of this coastline and the challenges we face to manage it.

The first stop was East Lane at Bawdsey. The rock armour here is a distinctive feature of the modern south Suffolk coastline, and now projects into the North Sea as the shoreline to the north and south have receded. There has been a long history of increasing intervention here - the beach of the late 19th century has gradually disappeared and the shoreline has receded - but the rock armour is considered an important anchor point on the coast, and helps to retain sediment in Hollesley Bay to the north.

On to Slaughden, Aldeburgh, the team walked along the narrow (< 80 m) strip of land separating the Alde estuary from the North Sea - a sight that highlights coastal vulnerability for all. Although the beach and land here is protected by groynes and a seawall, there is much debate over the likely future (and most appropriate management) of this system, and implications of a breach on the dynamics of the Alde and Ore estuaries and the Aldeburgh coastline.

On to Dunwich, we were able to reflect on a well documented history of coastal erosion where much of Dunwich village has been lost to the sea over the last few hundred years. Dunwich Heath provides a good viewpoint to look over the saline lagoons of Minsmere. These are a vulnerable but important habitat in the UK, significantly threatened by future coastal erosion and sea level rise. Juxtaposing this important wildlife reserve, but equally at threat from future climate impacts, the nuclear power

station of Sizewell also presents a striking feature on the horizon.

Travelling north to Southwold, we took a walk down to the north beach where the imposing seawall exudes a confidence of protection for the seaside town. In places, the limited beach and extensive rock groynes are perhaps less attractive for a beach holiday. To the north where the seawall ends, there is evidence of rapid cliff erosion, but the foreshore widens and the sandy beach here is clearly a popular spot for walkers.

The final stop before Lowestoft was Kessingland where the northward migrating Benacre Ness is currently residing. This widest point of this collection of beach ridges has moved almost 4 km north in the last 120 years, despite what is considered to be a predominantly southward sediment transport direction. Cliff erosion in this region is closely connected to the location of this feature, where the ridges become important protection to previously eroding cliffs to the north, whilst those to the south have been exposed and now exhibit significant erosion.

Although a whistle-stop tour, the team saw a good selection of coastal landforms and a variety of management interventions. It certainly provided a useful introduction to the system, and necessary context for the ensuing discussions of coastal system mapping.

Photo captions

A - Overlooking Minsmere, with Sizewell in the distance, from Dunwich Heath

B - Saltmarsh and embankment at Slaughden, Aldeburgh

C - A view to Southwold pier from the seawall and groyne beach to the north

D - The beach ridges and low dunes of Benacre Ness at Kessingland



iCOASST Stakeholder Workshops

Jonathan Simm (HR Wallingford) and Jon Lawn (University of Southampton)

Suffolk—22nd March 2013

A stakeholder meeting was held in Lowestoft 22nd March focussing on the Suffolk coast case study. Stakeholders attending included representatives from the Environment Agency, Suffolk and Waveney DCs, NFU, RSPB EDF and various local groups.

Stakeholders were introduced to the iCOASST project, the Coastal Systems Mapping methodology was explained and an application to the Suffolk Coastline presented. Key issues for the future of the Suffolk Coast were identified and discussed and the opinions of stakeholder were sought on:

- (1) the accuracy and visualisation of the Coastal Systems Mapping – some improvements identified
- (2) the key issues for modelling coastal evolution in Suffolk over the next 100 years
- (3) relevant sources of information and data
- (4) indicators required for the iCOASST models.

Stakeholders welcomed the iCOASST project and further interaction with it and as a result a further separate meeting was held with members of the Suffolk Coastal Forum and East Anglian Coastal Group on 26 June 2013.



Liverpool Bay—4th July 2013

Following the fieldtrip around the Sefton Coast with a selection of stakeholders from the regions, a stakeholder meeting was held in Crosby on 4th July focussing on the Liverpool Bay case study. Key Stakeholders, suggested by Sefton Council, attended included representatives from the Environment Agency, Sefton Council, NW Coastal Forum, Natural Resources Wales, Peel Ports and Natural England.

The iCOASST project was introduced to Liverpool Bay and it's coastal communities by the NW Coastal Forum. Consultants working on key projects in the area outlined the concepts and understanding of estuaries within Liverpool Bay.

Sefton Council outlined the policy context for coastal planning and decision making and introduced the iCOASST project to their regional monitoring and data collection programmes.

In response, stakeholders were introduced to the iCOASST project, and the Coastal Systems Mapping methodology was expanded upon and an application to the Liverpool Bay Coastline visualised for feedback.

Further engagement with stakeholders, how the iCOASST project can benefit stakeholders and the availability of data sets were all discussed.

Stakeholders welcomed the iCOASST project and we plan to visit North Wales within the next 12 months to see first hand some of the coastal management issues faced in another location within our Liverpool Bay study site.



Upcoming activities

- **Stakeholder Workshop:** iCOASST host a workshop for local stakeholder at the National Oceanography Centre in Southampton on 13th September 2013
- **iCOASST International Workshop:** iCOASST 2013: Simulating Decadal Coastal Morphodynamics 15-17 October. International experts are invited to exchange ideas and approaches for providing useful and informative predictions of decadal coastal morphodynamic to develop iCOASST methods and research plans.