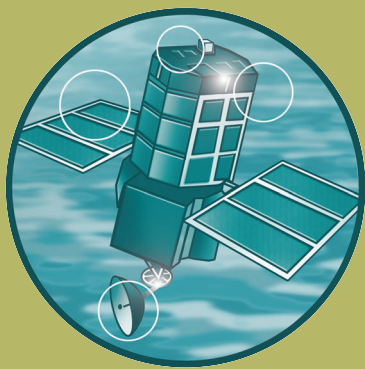


# Development and Demonstration of Systems Based Estuary Simulators (EstSim)

## Manager System Interface Report

R&D Project Record FD2117/PR6





**Defra/Environment Agency  
Flood and Coastal Defence R&D Programme**

**Development and Demonstration of Systems Based  
Estuary Simulators (EstSim)**  
Manager System Interface Report

Prepared by ABP Marine Environmental Research Ltd for the  
Estuaries Research Programme (ERP Phase 2) within the Defra and  
Environment Agency Joint Broad Scale Modelling Theme

Record No: FD2117/PR6

July 2007

## **Publishing organisation**

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April 2007

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### **Contract Statement**

This report describes work commissioned by Defra under Project FD2117 Development and Demonstration of Systems Based Estuary Simulators (EstSim). The Funders Nominated Project Officer was Kate Scott Environmental Agency. (Email: <mailto:Kate.Scott@environment-agency.gov.uk>.) The ABPmer Project Number was R/3434 and the Project Manager at ABPmer was Alun Williams (Email: <mailto:awilliams@abpmer.co.uk>).

### **Collaboration Statement**

This report was prepared by the EstSim Consortium comprising: ABP Marine Environmental Research Ltd (lead), University of Plymouth (School of Engineering), University College London (Coastal & Estuarine Research Unit), HR Wallingford, WL/Delft Hydraulics and Discovery Software.

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### **Keywords**

Behaviour, Estuary, Geomorphology, Modelling, Morphology, Systems approach.

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# **EXECUTIVE OVERVIEW OF FD2117: DEVELOPMENT AND DEMONSTRATION OF SYSTEMS BASED ESTUARY SIMULATORS (EstSim)**

**Manager System Interface Report, July 2007**

## **Purpose**

The Broad Scale Modelling Theme of the Defra/EA Joint Thematic R&D Programme for Flood & Coastal Defence has funded three contracts under the Estuaries Research Programme, Phase 2 (FD2107, FD2116 and FD2117). FD2117 (EstSim) started in April 2004 and has the following headline aims:

- To extend the ability to simulate estuary response to change.
- Facilitate knowledge exchange through accessibility of simulation results.

## **The Project**

ABPmer, University College London, University of Plymouth, HR Wallingford, WLU, Delft Hydraulics and Discovery Software are undertaking the project. The project is of 3 years duration (April 2004 - April 2007) and has nine Scientific Objectives as follows:

1. **System Conceptualisation:** Boundary setting and focusing of research effort.
2. **Development of Management Questions:** Rationalisation of management questions that can be informed through application of systems approach.
3. **Development of Behavioural Statements:** Formal definition of estuarine system in terms of systems approach and behavioural statements.
4. **Mathematical Formalisation:** Development of behavioural statements into a logically consistent mathematical framework.
5. **Development of System Simulation:** Development of architecture for estuary simulation based on the mathematical formulation of the system definition.
6. **Manager System Interface:** Explore the use of decision support systems and visualisation techniques for proof of concept testing.
7. **Pilot Testing:** Performance evaluation of estuary simulator.
8. **Dissemination:** Increase awareness of function and utility of research.
9. **Peer Review:** Ensure research lines deliver against Scientific Objectives.

This report draws on the information provided in the Behavioural Statements (PR2) and follows on from the System Simulation Stage (PR4) and describes the development of the web-based interface.

The work carried out within this Objective has gone beyond the tasks first identified at the proposal stage and rather than just scoping the elements required to create a manager system interface has been created that has drawn on all the relevant project Objectives.

**Contact Details**

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# 1. INTRODUCTION

## 1.1 Background

On 1 April 2004 ABP Marine Environmental Research Ltd (ABPmer) and its Project Partners were awarded research contract FD2117 (CSA 6064) within the Broad Scale Modelling Theme of the Defra/EA Joint Thematic R&D Programme for Flood & Coastal Defence.

The contract for FD2117 was awarded on the basis of a 'contract won in competition' after submission of a CSG7 (revised CSG7 submitted on 8 March 2004).

Entitled 'Development and Demonstration of Systems-Based Estuary Simulators' (hereafter EstSim), this research contract forms one of three contracts awarded under Phase 2 of the Estuary Research Programme (ERP). The two other contracts under the umbrella of ERP Phase 2 are (i) FD2107: Development of Estuary Morphological Models, and (ii) FD2116: Review and Formalisation of Geomorphological Concepts and Approaches.

The three phases of the Estuaries Research Programme seek to improve our understanding and prediction of estuarine morphological change over the medium to long-term, thereby facilitating strategic and sustainable decisions regarding flood and coastal defence.

The EMPHASYS Consortium undertook Phase 1 of this programme by evaluating existing morphological modelling approaches with the most promising of these approaches being developed within ERP Phase 2. It is anticipated that Phase 3 will seek to incorporate prior ERP research into an 'Integrated Estuary Management System'.

## 1.2 Project Aims

The overall aim of EstSim is to extend the ability to simulate estuarine response to change. This will be achieved through the delivery of research into the systems-based approach as an alternative yet complementary methodology to those research lines being undertaken within the other ERP Phase 2 projects (morphological concepts, bottom-up, top-down and hybrid methods). EstSim will also explore the simulation process in order to facilitate knowledge exchange between the systems-based tools and estuary managers. Integration of the systems based approach and existing methods is shown conceptually within Figure 1.

## 1.3 Project Structure

The project has been structured into nine Scientific Objectives, covering the required lines of research and dissemination:

1. **System Conceptualisation:** Boundary setting and focusing of research effort.
2. **Development of Management Questions:** Rationalisation of management questions that can be informed through application of systems approach.
3. **Development of Behavioural Statements:** Formal definition of estuarine system in terms of systems approach and behavioural statements.
4. **Mathematical Formalisation:** Development of behavioural statements into a logically consistent mathematical framework.



5. **Development of System Simulation:** Development of architecture for estuary simulation based on the mathematical formulation of the system definition.
6. **Manager System Interface:** Explore the use of decision support systems and visualisation techniques for proof of concept testing.
7. **Pilot Testing:** Performance evaluation of estuary simulator.
8. **Dissemination:** Increase awareness of function and utility of research.
9. **Peer Review:** Ensure research lines deliver against Scientific Objectives.

#### 1.4 Project Progress

A Workshop was held between the EstSim Project Partners on 8 March 2007 at which the results of Objective 5, the System Simulation and the subsequent report content (PR4) were discussed. The web-based interface developed within this objective (objective 6) was also shown to the Partners at this time and comments were provided on the function, appearance and content.

The coding behind the interface was provided to the appropriate Project Partners in order for them to carry out the Pilot Testing in Objective 7.

#### 1.5 Manager System Interface (Objective 6)

The objective of this research element was to explore the use of decision systems for facilitating knowledge exchange regarding the system approach and explore visualisation techniques to aid information accessibility.

The Manager System Interface was to increase functionality and accessibility for estuarine managers and provide a direct link between the Management Questions and the model outputs.

In order to deliver this research a number of sub-tasks were defined, as given in Table 1 at proposal stage. Through the objective lifetime however, these tasks were seen to only address some of the issues and it was decided that the development of an interface. Therefore these tasks have been met, and in addition this objective has delivered an interface to host the prototypes simulator and further disseminate the application of a systems based approach on estuaries.

**Table 1. Objective 6 Tasks**

Task	Description
6.1	Review of decision support methods (e.g. those used in SimCoast and ERAD).
6.2	Optimisation of decision support method for specific decision making requirements (in particular method/tool selection) and development of modular approach.
6.3	Review visualisation options suitable for the presentation of management information. Select tools to apply in conjunction with the estuary simulator, and to undertake tests suitable for proof of concept.
6.4	Produce technical report setting out the requirements of the Manager-System Interface, how well it can be delivered with the tools tested, and what further research and development is needed if this approach is to be implemented within the Environmental Management System (EMS) envisaged as part of ERP Phase 3 (Milestone 06/01).
6.5	Demonstrate simulator in parallel with Objective 5 at Technical Stakeholder Group meeting.

Delivery of this Objective Report completes all tasks required under Objective 6. This document constitutes Project Record PR5.

This Objective has been concerned with the web based interface development. This report therefore documents this development and the work completed within this Objective. However, the reader is also referred to the web-based interface itself ([www.discoverysoftware.co.uk/estsim/EstSim.html](http://www.discoverysoftware.co.uk/estsim/EstSim.html)).

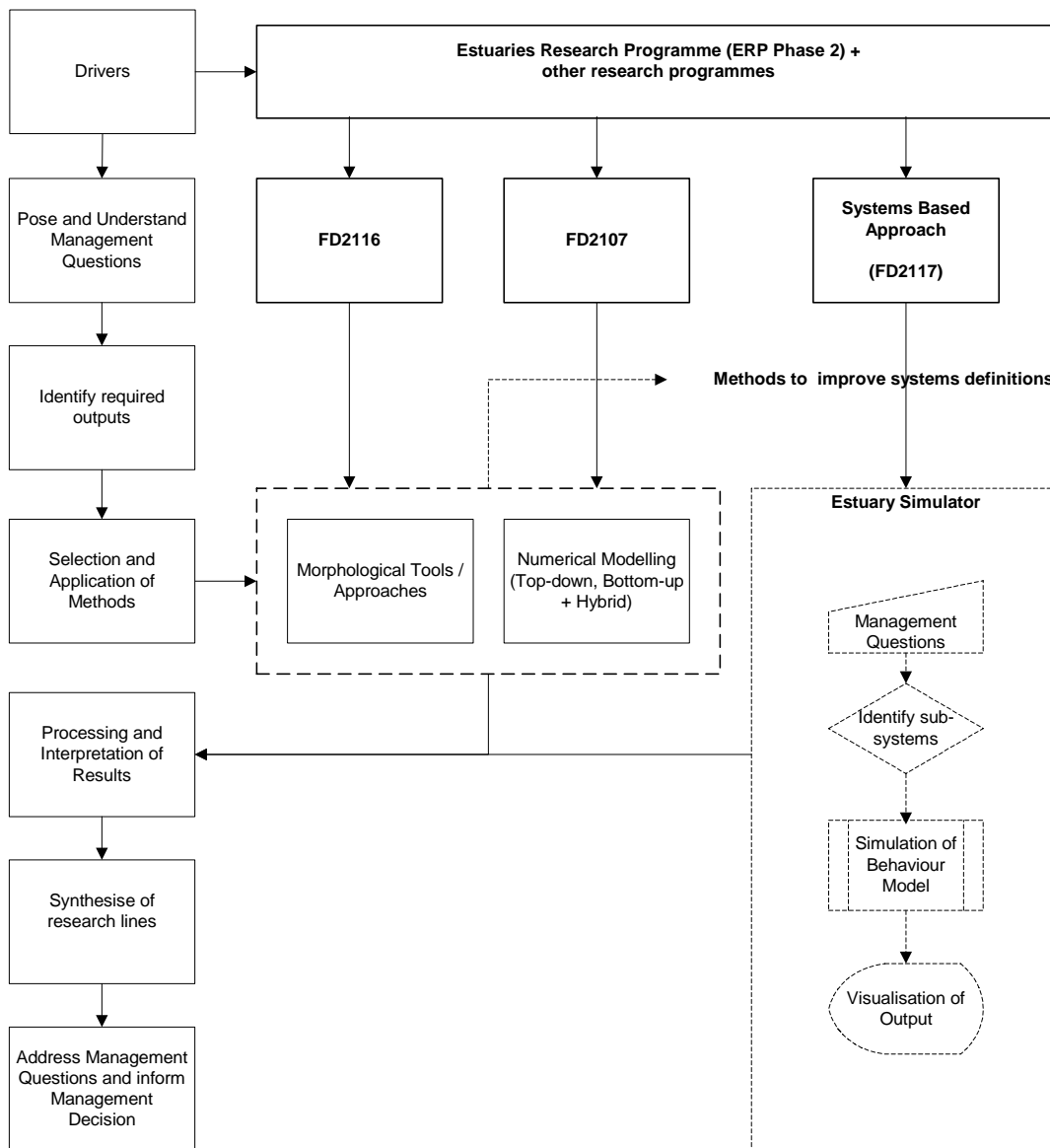
## **1.6 Follow-on Research**

The Behavioural Statements and Systems Simulation (Objectives 3 and 5) have provided the basis for the production of the web-based interface. The formulation of this framework and underlying Boolean logic has enabled the system to be tested using known examples for management requirements through the use of the Thames and Teign estuaries as case studies. This pilot testing has been undertaken within Objective 7.

## **1.7 Report Structure**

The report has been structured to capture the main tasks but re-ordered for ease of presentation and review, as follows:

- Section 2: Review of Visualisation Options;
- Section 3: Development of Interface;
- Section 4: Future Development of Interface;
- Section 5: Summary;
- Section 6: The Way Forward (Future Objectives).



**Figure 1. Integration of systems based approach**

## 2. REVIEW OF VISUALISATION OPTIONS

The document by Jon French and Helene Burningham entitled “Methods and software tools for estuary behavioural system simulation” (Project Record PR4) describes a number of possible options for visualization and dissemination of the EstSim tool including:

1. *Web-based estuary simulator and prototype decision support system*
2. *A web-based estuary simulator with server-side computational capabilities*
3. *Standalone estuary simulator*
4. *A semi-standalone estuary simulator*

The report recommended that a combination of approaches 1 and 3 might be the most fruitful and achievable within FD2117 but that approach 2 would be more beneficial in the longer term. After reviewing the various options, timescales and assessing the end users of the system it was decided to actually develop an interface based on approach 2.

### 2.1 Selection of a Preferred Option for Implementation

The preferred option enables access to and exploration of the model by anyone with access to the World Wide Web. It is therefore open to all types of end users including, estuary managers, government institutions, research establishments, educational facilities and indeed the general public. The interface was developed using Macromedia Flash, for which there is a free, downloadable player available to anyone on the web. There is therefore no cost associated with using or viewing the prototype simulator via the EstSim interface.

Using Flash to provide an interface for the EstSim prototype simulator also provided a means of incorporating other data on the web site. The design of the interface therefore includes:

- i) An introduction to the FD2117 project
- ii) A description of how estuaries can be classified
- iii) A description of geomorphic types
- iv) Access to the estuaries database
- v) A description of the EstSim modelling approach
- vi) Access to and control of the EstSim model in terms of
  - a. Running generic estuary models
  - b. Creating and running customised estuary models
  - c. Running models from two study areas

This approach therefore also overall allows for dissemination and knowledge transfer to estuary managers regarding the system approach in line with the overall objective of the project.

### 3. Development of interface



Figure 1 - The main screen of the interface

Figure 1 shows the first screen you see when starting up the interface to the EstSim tool. It is accessed via <http://www.discoverysoftware.co.uk/estsim/EstSim.html>. The interface has a number of menu buttons (on the left) and circular buttons (in the centre) which allow access to different parts of the system. For instance by clicking on the Introduction button the interface will show text providing an introduction to the project (Figure 2).



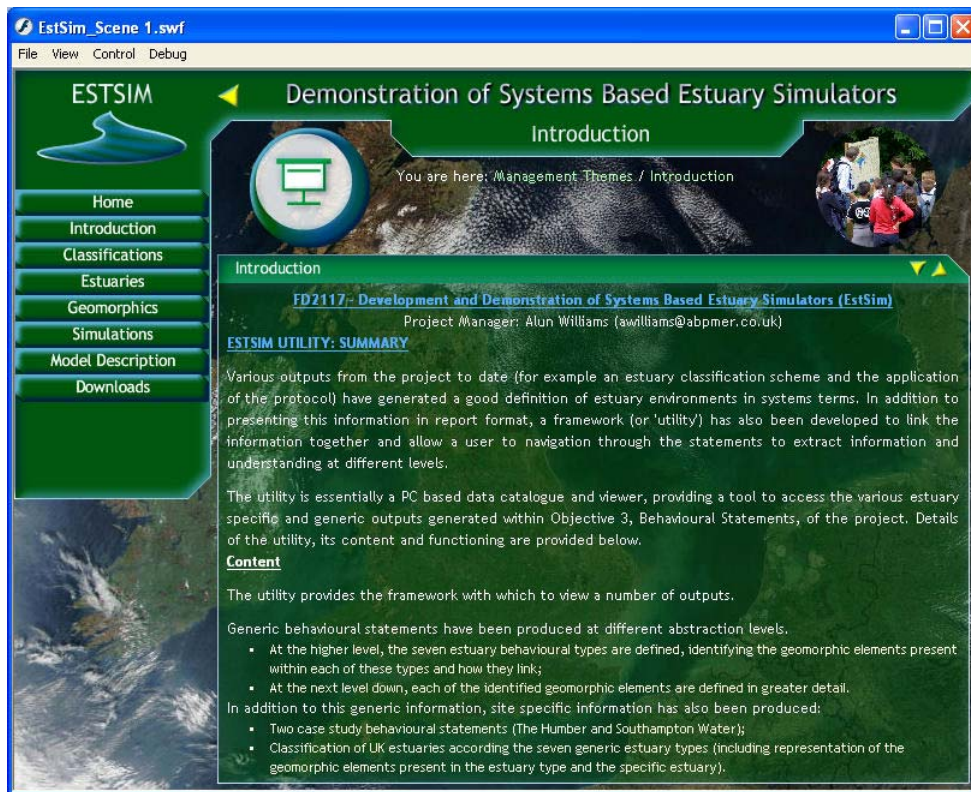


Figure 2 - An introduction to the EstSim project

Other buttons including the Classifications, Geomorphics, and Model Description buttons provide more detailed descriptions which are further investigated using a series of tabs and vertical menus (see Figure 3). Clicking on a topic in these menus provides more detailed information for that topic (Figure 4).

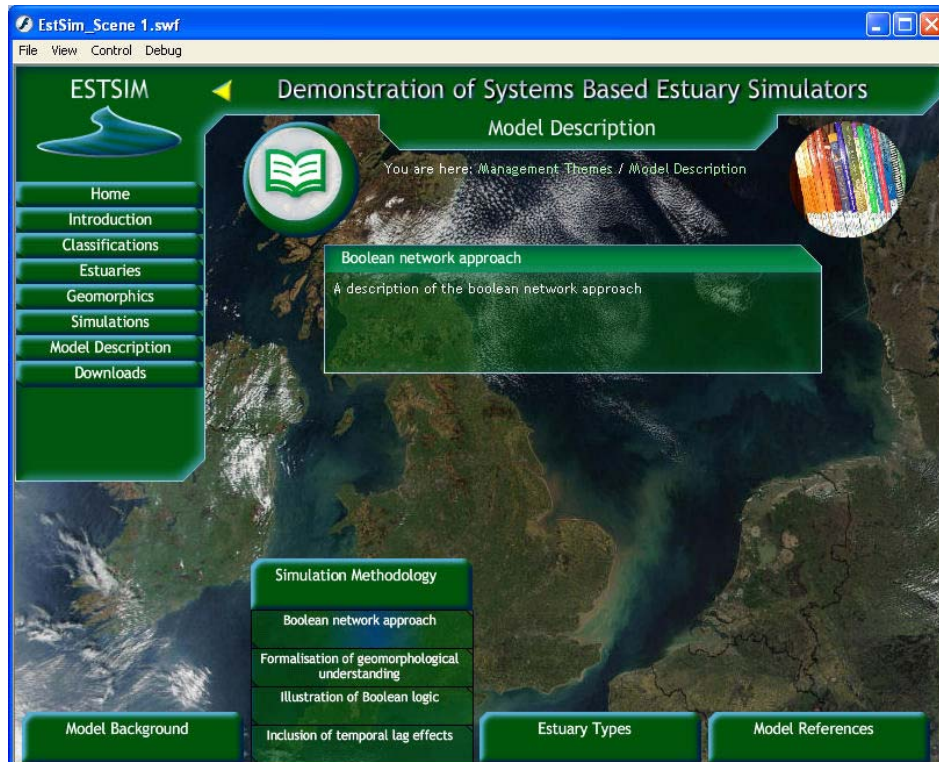


Figure 3 - Further information is available via tabs and vertical menus



Figure 4 - After clicking on a topic further information is displayed

The Estuaries buttons provide access to information in the UK Estuaries database. Estuaries are listed alphabetically and different estuaries can be selected by clicking on the appropriate letter and then the estuary of choice. Figure 5 shows details for Aberystwyth. Items with a 3D appearance can be clicked on to find out more information about certain geomorphic types or to proceed to a model for that estuary type.



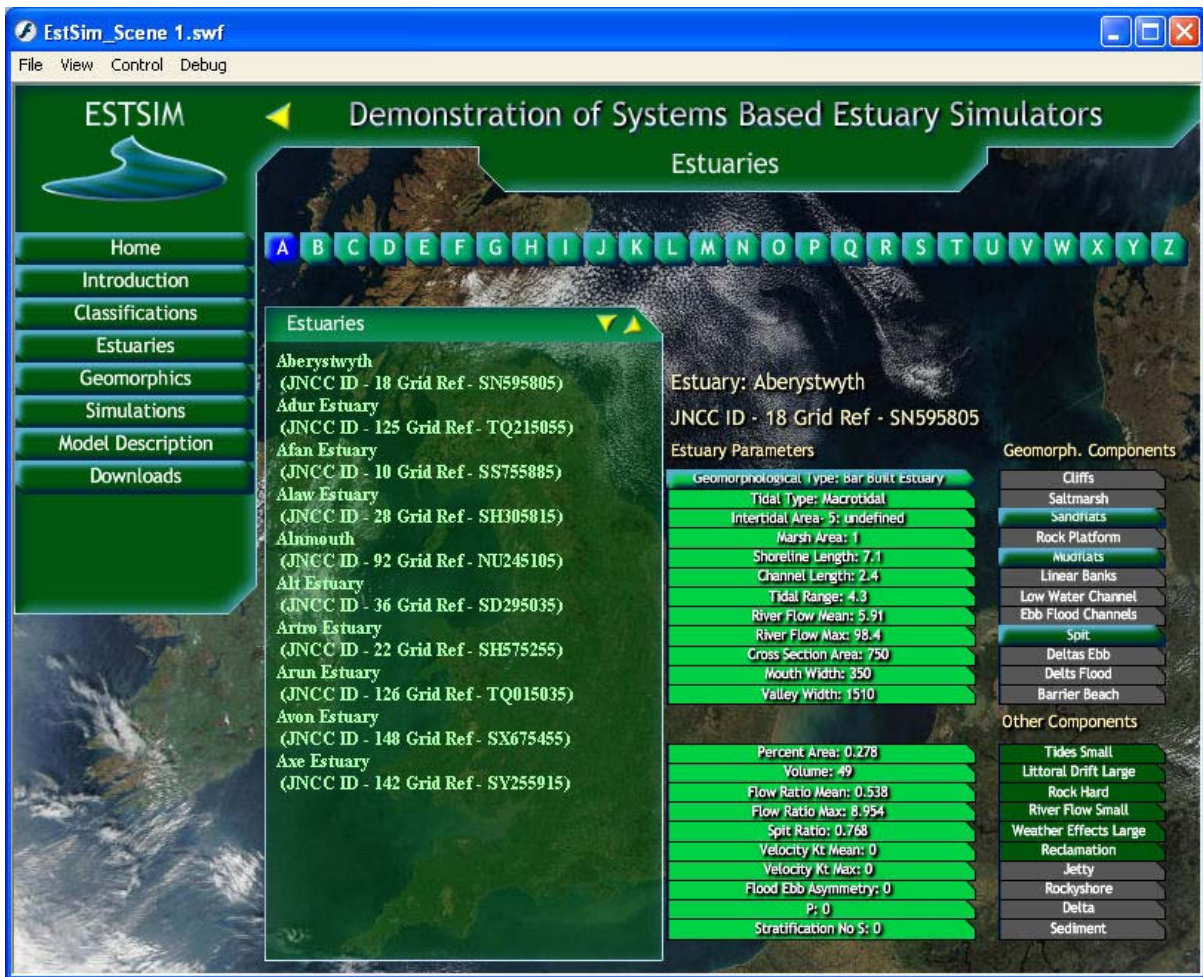


Figure 5 - Estuary information from the UK Estuaries Database

Clicking on Simulations will take the user to the prototype simulator. The four tabs provide access to generic estuaries, creating a scenario of the user's choice or to scenarios relating to the two study areas, the Thames and the Teign. Figure 6 shows the interface for creating a new scenario based on a generic fjord.





Figure 6 - The model interface

The interface shows different elements of the estuary grouped by fluvial, inner and outer estuary, coastal/marine systems. There are also options to specify interventions and strategies. The 3D green buttons show those elements that are present in a generic fjord. The user can turn these off by clicking on them or turn other elements on by clicking on those elements. Once the user has defined their estuary they can run the model by clicking on the cog/clock icon (lower left). Once the model has been run the results are displayed using the same interface. A time bar appears below the estuary elements showing each step in the model. Figure 7 shows 21 steps where steps 13-20 are repeated.

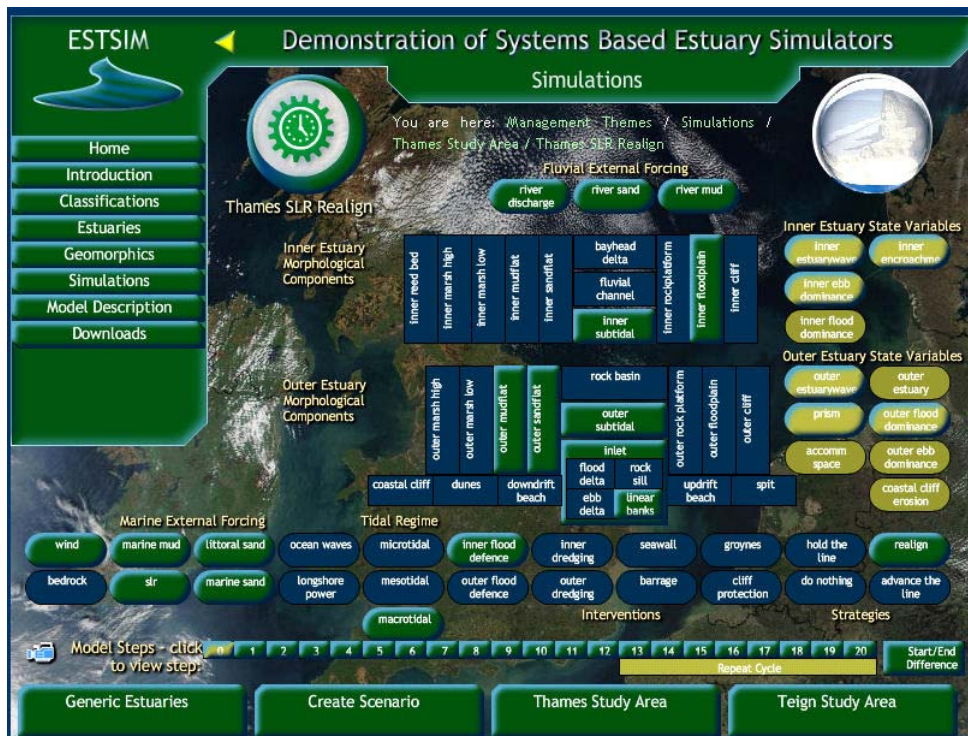


Figure 7 - Illustrating the time bar which gives access to the model results.

Any step can be highlighted by clicking on the appropriate step in the time bar. Figure 8 shows the results for one particular step in the model results. Those elements that are highlighted in 3D are currently switched on; those that have a green border were previously off but are now on, while those with red borders were previously on but are now off.

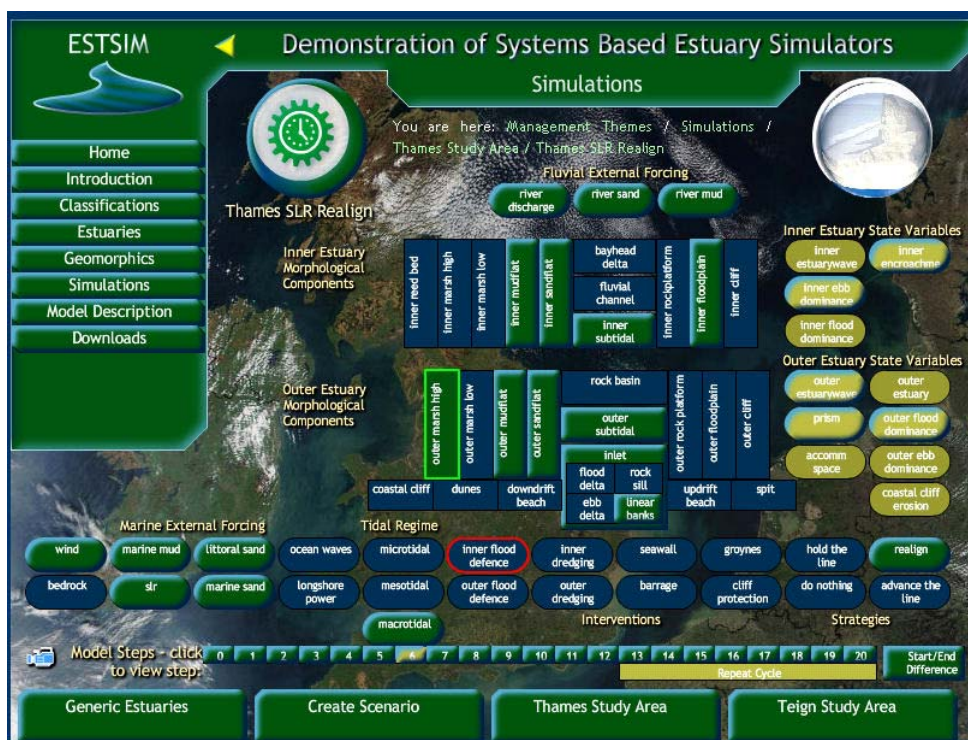


Figure 8 - Illustrating the results at one step in the model.

The user may also click on the Start/End Difference button to summarise what has been switched on or off during the entire run. Finally, the user may animate the whole model run by clicking on the Camera icon (lower left).

Technically, the interface has been developed using a combination of Flash, Javascript, Active Server Pages and a MySQL server database. This communication between each element is shown in Figure 9.

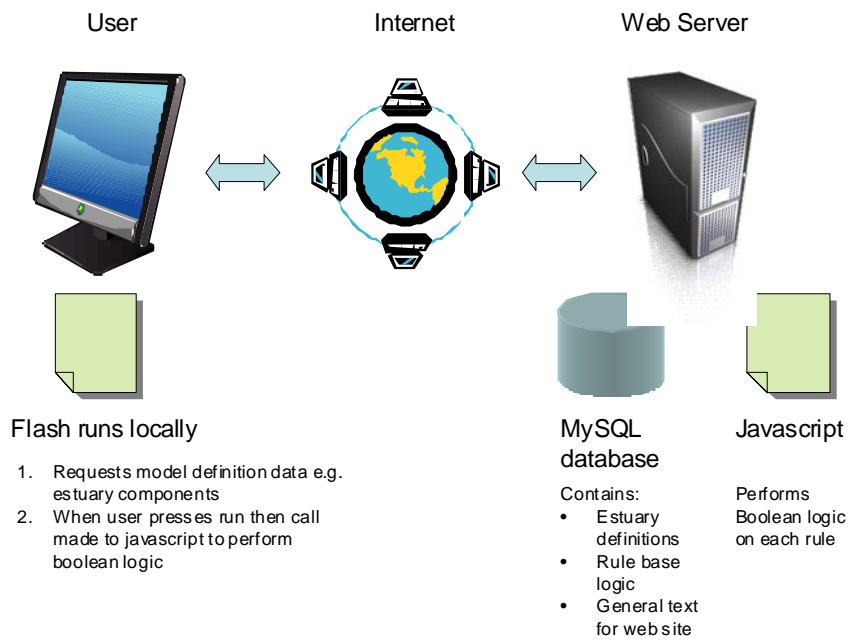


Figure 9 - Communication setup

#### **4. FUTURE DEVELOPMENT OF INTERFACE**

Possible future developments of the interface include the following:

- i) Editing of rules - allowing users to edit rules or create their own rules;
- ii) Creation of new entities in the model, e.g. a new type of defence or management scenario - this would obviously require new rules to be added to the system defining how the new entity relates to other parts of the estuary system; and
- iii) The ability to save a session and continue from a previous session. This would require a user logon system and saving/reading session data from the server database.

## **5. THE WAY FORWARD (FUTURE OBJECTIVES)**

Objective 6 has provided a framework interface to host the prototype simulator and facilitate knowledge exchange regarding the systems approach and its application to UK estuaries within FD2117. The interface therefore hosts the work completed as part of the System Simulation and Behavioural Statements Objectives.

In order to facilitate the translation of the outputs from Objective 6, as presented within this report, into a way forward for Objective 7, a Translation Workshop was held on 11 June 2007. Project partners and Defra's project officer attended the workshop. The work completed within Objective 6 was presented at the meeting and the participants discussed both this and how it could be translated into the next objective.

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