PRESENTATION OF FINDINGS

This chapter:

- Explores ways in which the findings from coastal studies can be communicated to others and provides a number of worked examples of the techniques outlined;
- Reviews the ways in which data and results can be presented effectively within a report;
- Discusses space-time summaries as a useful method for conveying the behaviour of an estuary, temporally and spatially; and
- Includes a sediment budget to emphasise how results can be collated and synthesised effectively.

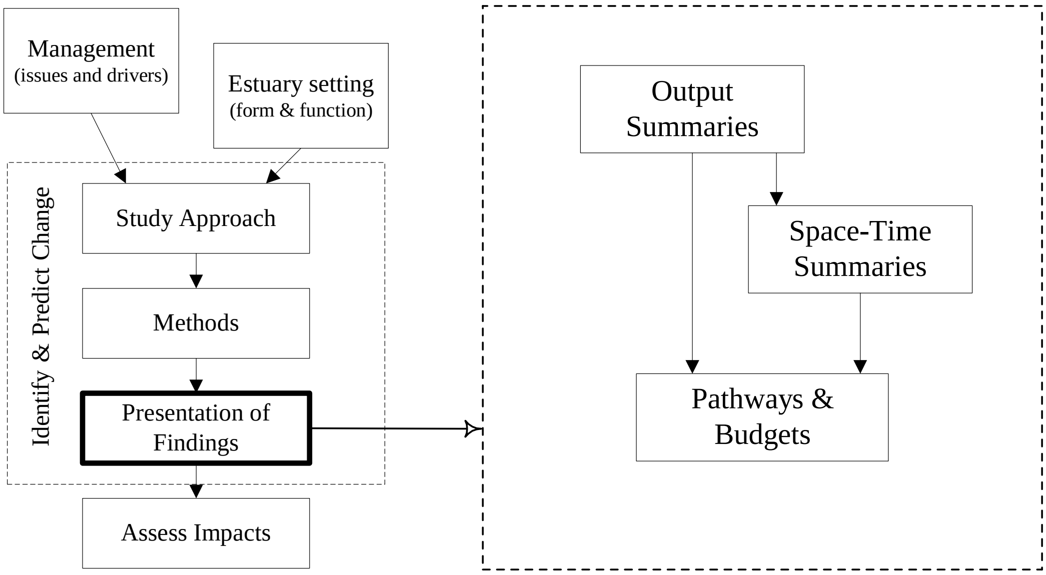


Figure 6.1 Flow diagram illustrating the methods of presenting findings

Synthesis Report

To complete the study process, the results must be documented in a way that explains the conceptual model and makes clear any uncertainties. There is no established way of doing this and the approach is likely to vary from one situation to another. In most cases, the conceptual model will comprise a written description, illustrated with results, schematic figures and flow diagrams. It is unlikely that the format of output available from a single technique will be sufficient to fully describe the conceptual model (Figure 6.1). The complexity arises because one is often trying to present a number of behavioural concepts that interact over different space and time scales. Without any clear hierarchy this can be difficult to communicate. Whilst there are various forms of system diagrams that allow the linkages to be identified, such techniques often fall short of encapsulating the behaviour of the system.

Typically the synthesis report might include:

(i) A description of the estuary and a summary of the estuary characteristics (estuary setting);
(ii) The summary of the results from each of the analysis/model outputs (Box 6.1);

(iii) Space-time summaries for the existing case and any scenarios investigated (Table 6.3);
(iv) More detailed descriptions to support the individual summaries given in the space-time table (e.g. Humber Holocene chronology);
(v) Further description of how the system will respond to the scenarios envisaged, such as sea level rise, dredging, flood defence;
(vi) Maps of sediment pathways (Figure 6.1) and a sediment budget for the various scenarios;
(vii) Identification of the most sensitive behavioural response mechanisms for the particular estuary; and
(viii) A summary of the conceptual model and how the various studies support the model with accompanying notes on any areas of uncertainty.

A case study, which illustrates many of the concepts presented here, is given in the paper on Southampton Water case study. The following sections explain some of the presentation techniques in a little more detail.

Summaries of Individual Studies

Each individual analysis or modelling approach is usually documented, or reported in its own right. This ensures that details about the method used, assumptions, calibration and validation, sensitivity, etc are all captured and can be revisited if they appear to have a particular relevance to the synthesis. Such reports can be copious in their own right and do not therefore lend themselves to the overall presentation of findings. One way of distilling this is to prepare brief summaries of the individual studies (Box 6.1). It may even be necessary to summarise this further, presenting just the key findings or conclusions, in order to give a concise but reasonably complete overview of all the studies undertaken (Box 6.2).

Box 6.1 Example of output summary

Intertidal Form

To explore an appropriate form for the intertidal recharge, some work was undertaken fitting existing intertidal profiles, taken along the Hythe to Cadland shore, to a theoretical form. The theoretical form was derived by considering wave energy dissipation over the intertidal and mud density (Lee & Mehta, 1997). Furthermore, the shape of the profile is thought to provide an indication of stability of the shore, with convex-upward profiles being accretionary and concave profiles being erosional (Kirby, 1998).

Key findings:

The equation was found to give a very good description of the existing cross-shore profiles. The values are given below, and can be compared with the reported values of Lee and Mehta (1997):

Table 6.1 Parameters for fitting the Lee and Mehta profile

Parameter	Actual	Accepted Range: Mean (st.dev)	
		Erosional	Accretional
Wave attenuation coefficient, k_i	0.0007	0.420 (0.130)	0.016 (0.027)
Foreshore slope, F	0.0450	0.058 (0.083)	0.026 (0.019)
Depth correction factor, β	0.0068	0.046 (0.054)	0.015 (0.008)

The form of the profile is weakly accretional having a convex form in its lower portion. In the upper part, the profile exhibits scour due to wave breaking at the shoreline, as indicated by the relatively high value of foreshore slope. These results are consistent with the erosional scarp observable in front of the saltmarsh and the noted potential for sediment deposition over an area that covers the lower intertidal.

Box 6.2 Distillation of key findings to a bullet point summary

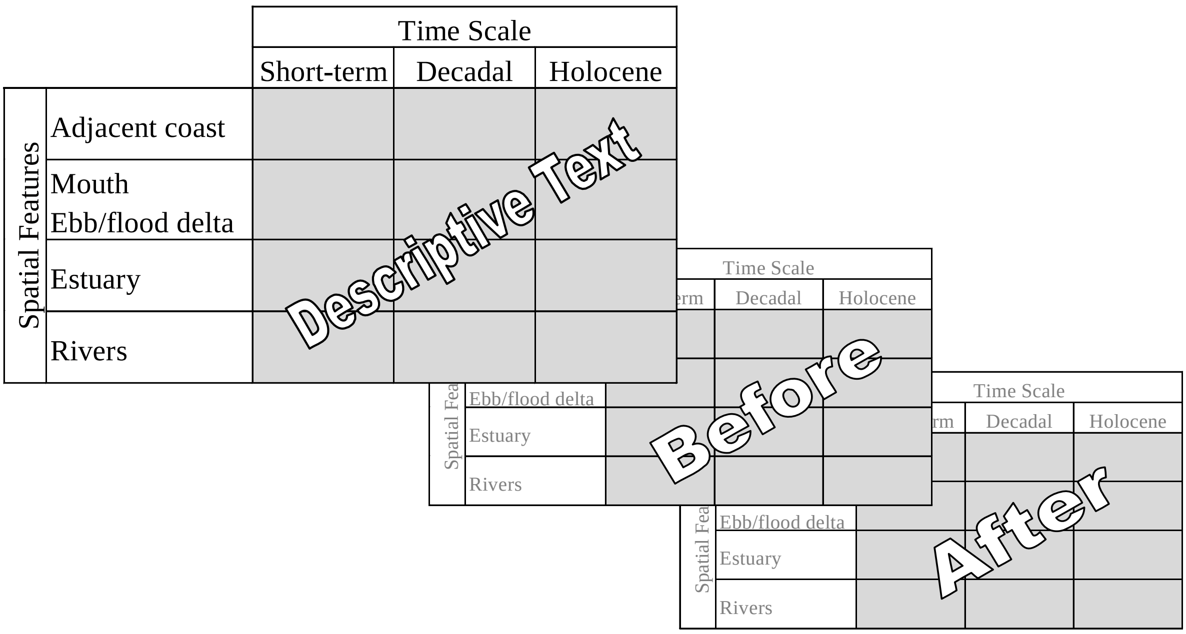
In this example the findings of the study summarised in Box 6.1 are distilled down to the key findings:

Method	Findings/Understanding
Intertidal form analysis	• The existing foreshore at Hythe was found to be well represented by the Lee & Mehta profile; • The form of the profile is weakly accretional, with scour due to wave action at the shoreline.

Space-Time Summaries

One way of communicating this complexity to the user is to describe the behaviour in a series of space-time intervals. Using a table, where the columns define time intervals and the rows various spatial elements that make up the system, an explanation of the mechanisms at work and the resultant behaviour can be given, as illustrated in Table 6.2. Individual cells in the table can then link to sections in the explanatory text (or separate reports) that provide a more complete explanation. In addition the same format can be used to summarise the existing situation and the behaviour predicted for a given set of imposed changes (e.g. sea level rise, new development, etc). This is particularly valuable if there is a need to use the results in some form of impact assessment.

Table 6.2 Table to summarise space-time changes



An example of this approach, based on work carried out in the Humber for the estuary shoreline management plan (Winn *et al.*, 2002), is shown in Table 6.3, for the existing situation.

Table 6.3 Summary of space-time changes for the Humber Estuary (Winn *et al.*, 2002)

Time Scale / Feature	Holocene Change (8000BP-Present)	Decadal Change (10-100 years)	Short-Term Change (Tides and Storms)
Estuary	Landward transgression due to predominantly monotonically increasing sea level. Physical constraint of the sill at Hull has had a major influence on the estuary form as sea levels have risen.	Continued adjustment to both sea level and the reclamation of large areas of upper intertidal. Estuary has infilled whilst maintaining the overall volume of water as sea level has risen. Some evidence of landward transgression, with shorter-term response to variations in sea level (e.g. lunar nodal cycle).	Significant sediment flux and bed level changes dominated by tidal flows, with fresh water flows having increasing influence landwards and waves and density currents influencing movements in outer estuary.
Mouth	Mouth retreats along line of channel from New Sand Hole to present position	Acts as a tidal embayment. Spurn has been held by defences but is now beginning to realign as defences fail.	Major circulation cell around Bull Sand Fort. Storm action eroding the Holderness cliffs influences sediment supply to Spurn and the estuary.
Meanders	Channel alignment seaward of Hull cut into the tills by ice melt and subsequently fluvial flows. Tidal waters have progressively occupied and infilled the channel, with periods of stable alignment and periods of migration.	Meanders in the outer Humber are constrained by underlying till. In the inner Humber, channel switching from south to north of Read's Island is a result of large river flows, in conjunction with periods of relatively high tidal range. The training works at Trent Falls have reduced the length over which this switching occurs.	Switch of meander from south of Reed's Island into the Redcliff channel happens in response to major flood events. The switch back, to north of Read's Island is more of a progressive migration. If the period between flood events is long enough, the channel switches to south of Reed's Island.
Rivers	Humber lake infilled initially with fluvially derived sediments, followed by the formation of tidal channels once sea level rose over the sill at Hull. Some evidence for substantial movement of the river alignment.	Heavily constrained by flood defences all the way to the tidal limit on the main rivers. There is a gradual switch, some 20km above Trent Falls, from tidal to fluvial dominance. There appears to be a cyclical link between fresh water flows and sedimentation in the outer estuary.	High flows during winter periods with very little storage space. Trent is artificially charged and so low summer flows not as significant on this river.
Ebb/flood delta	Only evidence is the scour holes in the palaeo-channel out to New Sand Hole, which suggests that any sand bank/delta formations migrated with the mouth	No evidence of a delta in the vicinity of Spurn. Hydraulic and sedimentary evidence indicates circulation cells around Foul Holme Spit and Middle shoal, suggesting that the delta may operate about a "mouth" at the neck just west of Hawkins Point and Grimsby	Middle shoal exhibits rapid change and also responds to longer-term trends, which appear to be linked to variations in fresh water flow. Foul Holme Spit exhibits less rapid, more progressive changes.

The explanation of the space-time summary and the assessment of how the estuary may change under different scenarios of sea level rise or the removal of various lengths of sea defence are explained more fully in the synthesis report (ABP Research, 2000). Hence, in this case the conceptual model is not a single description but rather a multiple space-time description, where there is an appreciation of the relative importance of individual behavioural components but the precise interactions between components is not fully understood.

Sediment Pathways and Sediment Budget

In order to understand how the estuary is evolving, a useful starting point is to try and establish how the sediments are being redistributed. Typically this is a set of vectors showing the direction, with the length of the arrow depicting the magnitude. This generally requires the separate consideration of the fine and coarse fractions, as they invariably respond to different characteristics in the forcing conditions. However, they can be presented together, in a map of the main pathways (Figure 6.2). This type of presentation can be used to combine data from a variety of sources. For example, Figure 6.2 simply denotes direction, whereas in Figure 6.6 some indication of different types of transport and their relative magnitude is also provided. As an alternative form of presentation, the arrows can be drawn in a way that indicates the confidence there is in a particular pathway. So, a solid thick arrow may indicate a high degree of confidence, a solid thin arrow - a somewhat lower confidence and a dashed arrow (or arrows going in opposite directions) - a degree of uncertainty or conflicting evidence.

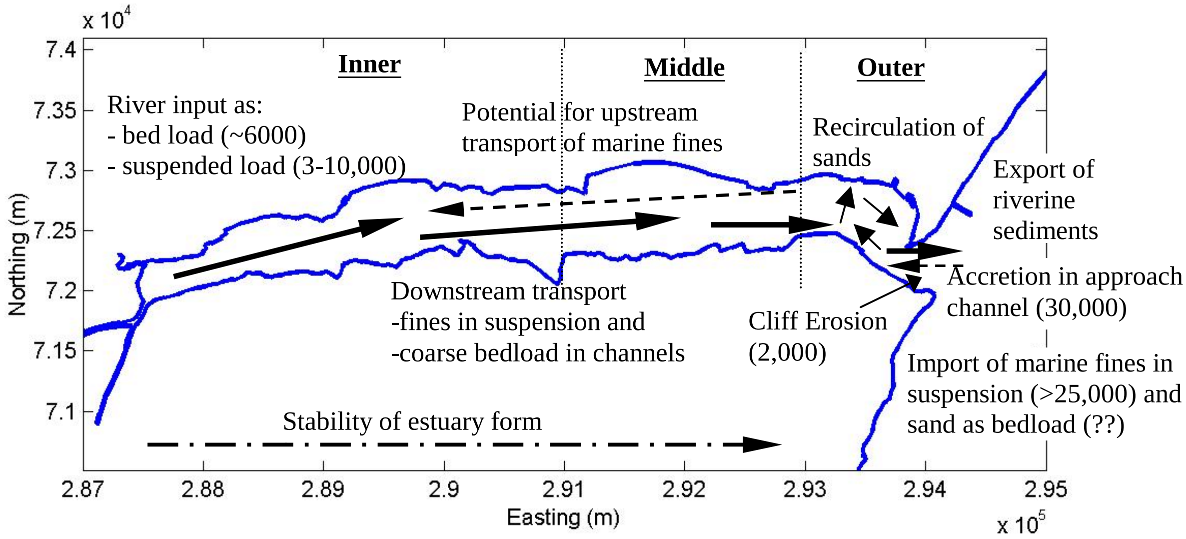


Figure 6.2 Map of indicative sediment pathways for the Teign estuary

One of the most useful summaries of estuary behaviour is the sediment budget. This describes the main sediment exchanges, both in and out of the estuary and internally (Figure 6.3). Further refinement can add detail to the description of the various sediment transfers. It must be recognised that this says very little about the current state of the estuary or how this state may change in the future. A future development may be to produce a time dependent budget for given scenarios. However, this would require a substantial amount of information about all the components of the system and so demands a high degree of confidence in the predictive capability of the models being used, to justify the effort required.

In many cases, it can be difficult to identify, let alone quantify, all the mechanisms that give rise to sediment transfers. It may however be possible to derive approximate estimates of the amounts moving to and from sources and sinks based on measures such as transport potential and sediment demand. In effect, one establishes an account and as with any account, the prime requirement is that it balances. For this reason, Pethick suggested the sediment audit as an approximate balance that could be carried out on a number of scales (e.g. local, sediment cell, or regional). The relative importance of changes in supply and demand could then be assessed at the different scales being considered (Pethick, 1992).

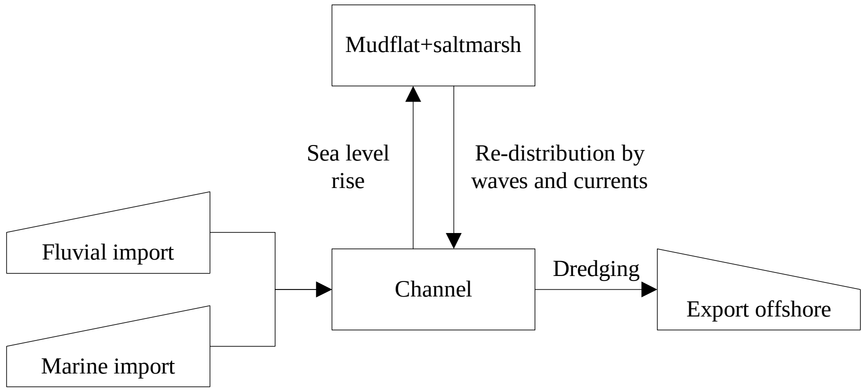


Figure 6.3 Simple example of sediment budget concept

An example of how to formulate a net sediment budget is proposed in Townend and Whitehead (2003), and the result is illustrated schematically in Figure 6.4. This focuses on the net (long-term) exchanges between key features of the system, whilst noting some of the gross movements of sediment (e.g. the amount moving back and forth on every tide).

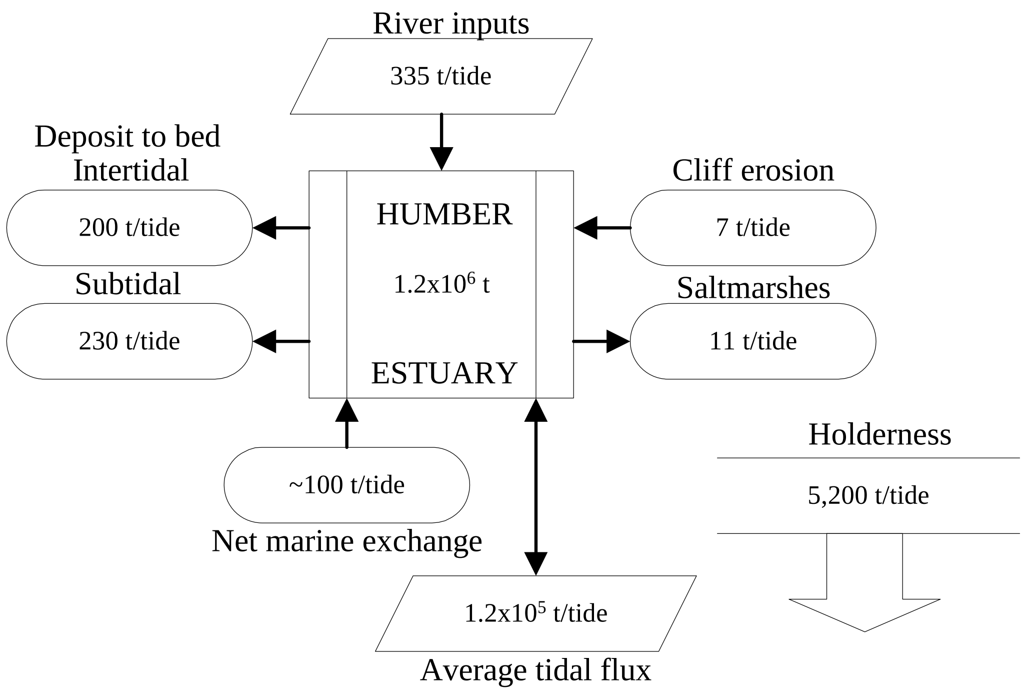


Figure 6.4 Schematic for net sediment budget for the Humber

An alternative, is to present the same sort of information on a schematic map of the estuary, so that the spatial relationship of the exchanges can be seen (Figure 6.5).

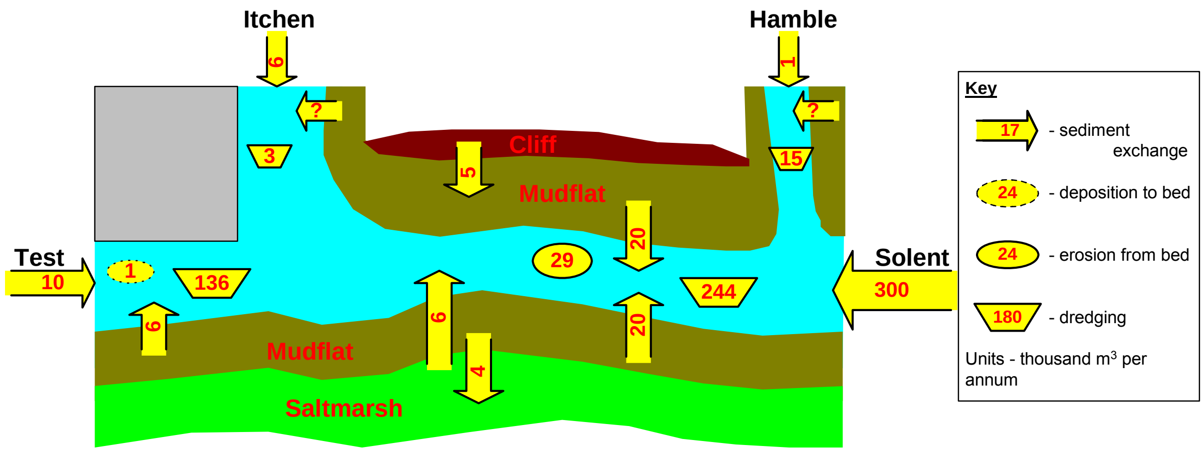


Figure 6.5 **Mapped schematic of sediment budget for Southampton Water**

For many studies of change, one of the main objectives is to determine how volumes and areas are likely to change and what this is likely to mean for the extent of particular types of habitat. Quantitatively this can be reported in tabular form but it is often helpful to illustrate this with maps or sketches to show just where and how the changes are likely to take place. One form of this is to map the areas of erosion and accretion as shown in Figure 6.6, which also includes arrows to illustrate the main sediment pathways. However this only provides a limited view of how the form is changing, particularly if vertical and horizontal changes are happening simultaneously but usually at very different rates. An alternative, therefore, is to use sections to show the various rates of change and how this effects the extent of subtidal and intertidal area (Figure 6.7).

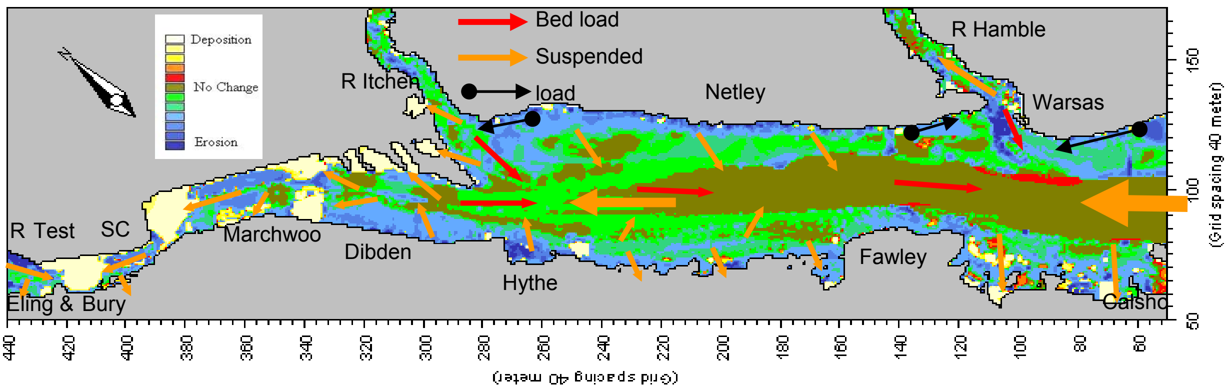


Figure 6.6 **Annotated model output of erosion and accretion to illustrate sediment exchanges**

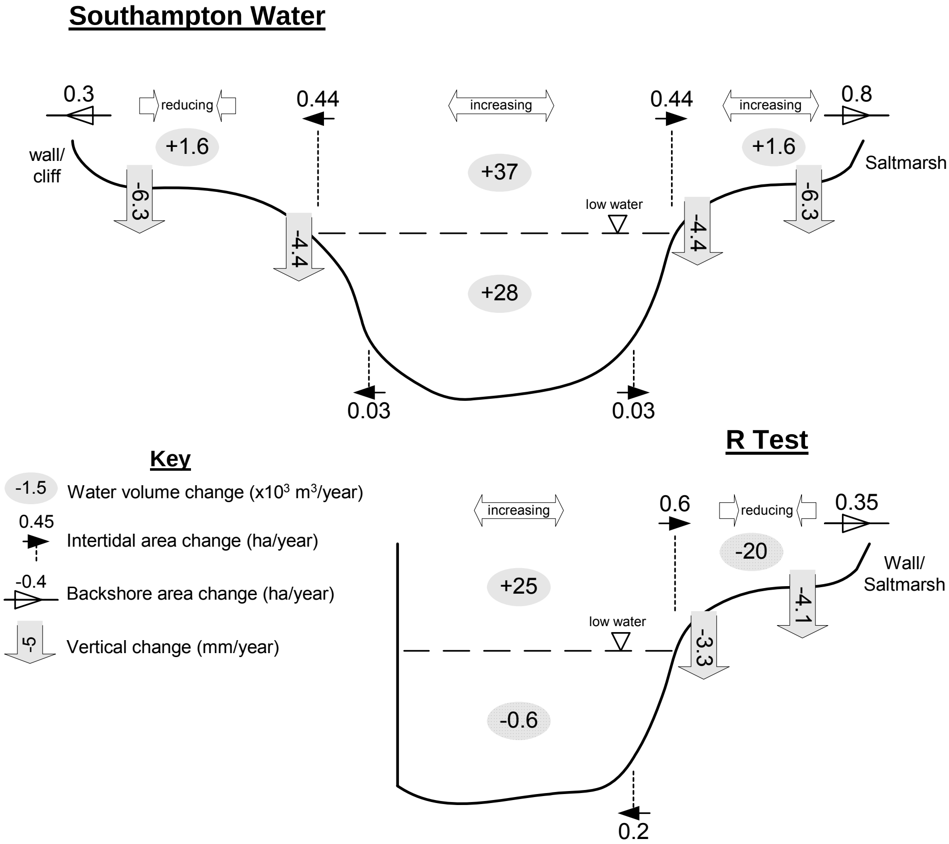


Figure 6.7 Summary sections illustrating key changes to estuary form

Model output on its own does not usually have a particularly high explanatory power. However, if combined with suitable annotation, or reworked into schematic figures, it can have a much greater value, as I have tried to illustrate in a number of the figures shown in this section.

Conclusions

One of the difficulties in identifying morphological change in estuaries is that there is as yet no well-defined theoretical framework. The constituent processes are understood to a greater or lesser degree but the basis for formulating the behaviour, related to dynamic equilibrium states, is far less developed. The process outlined seeks to use the methods and techniques that are currently available, to identify system behaviour in a way that is transparent, with a clear recognition of the current uncertainties.

A key to this process is the synthesis of the study findings and the way in which the results are presented. Both of these areas would merit further research. For the former, the development of a more formal experimental basis may be of benefit (Mayo, 1996). For the latter, interactive presentations, with the user able to investigate particular aspects in more detail, supported by a mix of graphics, animation and text, may well provide the way forward.

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