COUPLED HYDRAULIC AND ENERGY RELATIONSHIPS

Given the difficulty of predicting the changes that result from sediment transport processes, particularly in estuaries with mixed sediments, one option is to look at the changes in bed shear stress under different scenarios. The hydraulic model is used to predict the flows under the various scenarios under consideration and the changes in bed shear-stress patterns are used to infer the likely changes. For example in Figure 1, there is a clear switch in the main channel from reduction in shear stress upstream (blue) to increase in shear stress downstream (orange), leading to the likelihood of infilling upstream but erosion downstream to cope with the additional tidal prism introduced by the removal of the defences.

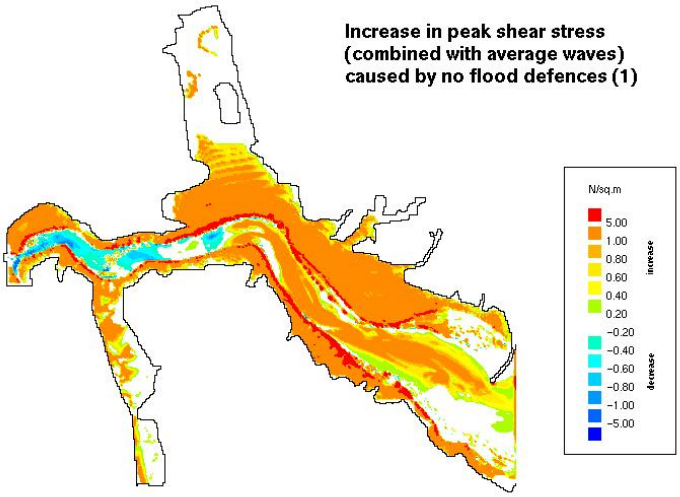

Figure 1 - Peak bed shear stress from study of Humber estuary (model output by HR Wallingford)

The use of bed shear stress has been introduced into a tidal prism type regime model, as a means of determining the basic form of any given cross-section. By relating the bed shear stress to the critical erosion and deposition thresholds, an equilibrium depth can be predicted, which, in conjunction with the cross-sectional area, allows the width to be estimated (see Paper 13 of the EMPHASYS Report).

Within the field of river engineering, there has been extensive attention given to the concepts of uniform energy dissipation per unit of bed and uniform stream power (Yang & Song, 1979; Song & Yang, 1980). These concepts link closely with that of minimum work or entropy production as discussed in the coupled hydraulic and entropy relationships section. It is likely that future developments will result in a closer integration of the two concepts to a single coherent understanding. Some elements of this have been put together for fluvial regime channels by Yalin and Ferreira da Silva (2001, see p87 for discussion on the variation of flow energy structure with the passage of time).

References

Song CCS, Yang CT, 1980, Minimum stream power: theory, Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, 106(HY9), 1477-1487.

Yalin MS, Ferreira da Silva AM, 2001, Fluvial processes, IAHR International Association of Hydraulic Engineering and Research, Delft, Netherlands.

Yang CT, Song CCS, 1979, Theory of minimum rate of energy dissipation, Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, 105(HY7), 769-784.