FORM ANALYSIS

Method Indicator		
Bottom-Up	Hybrid	Top-Down
		YES

Summary of key issues

Issue	**Description**
Description	The use of power laws to describe the longitudinal variation in the width and depths of estuaries and creeks; and to generate a 3-D result that can be fitted to a wide variety of forms exhibited by creeks and estuaries.
Temporal Applicability	Can be applied to 10 – 100 years (medium term) with sea level rise.
Spatial Applicability	Whole estuary or individual channel.
Links with Other Tools	Estuary Translation; can provide a useful representation for exploration of analytical and numerical tools.
Data Sources	• Estuary parameters, including position of longitudinal thalweg (total depth), width, hydraulic depth, tidal wave propagation; • Coastal protection / defences; • Description of surrounding catchment to provide setting.
Necessary Software Tools / Skills	Mathcad experience.
Typical Analyses	Exploring the magnitude of estuary transgression, and design of intertidal creek systems.
Limitations	Only considers sediment balance and so may require some input from other type of model in order to make predictions.

In developing an analytical solution for tidal wave propagation in estuaries, Prandle & Rahman (1980) made use of power law representations to describe the longitudinal variation in width and depth. This was found to be a particularly flexible formulation allowing most estuary forms to be accommodated. The description is for width (B) at mean tide level and the hydraulic depth (H) at any given section (L), as follows (Equation 1):

$$B = B_L . \left(\frac{x}{L}\right)^n \quad \text{and} \quad H = H_L . \left(\frac{x}{L}\right)^m \qquad (1)$$

The values of the shape parameters, n and m, determine whether the form is a funnel (convex to centre-line) or bell shaped (concave to centre-line). These two equations have been used as the basis of generating a 3-D results that can be fitted to the wide variety of forms exhibited by both creeks and estuaries. The model is based on a longitudinal thalweg (total depth and not hydraulic depth) defined about a zero datum in x and z (the shoulder). As x becomes negative, so the profile inverts to give the longitudinal section (Figure 1). In the model, the ability to define scaling lengths and shape factor (H_L, L and m) for the descriptions above and below the zero datum provides great flexibility. To define the plan form, the origin at any given level, z, is moved to be coincident with the position (x chainage) of the thalweg at that level (the plan form is set to zero for negative values relative to the transformed origin) (Equation 2). Depths can then be calculated from the following relationship:

$$z(x,y) = D.\left(\frac{x}{L} - \left(\frac{y}{B}\right)^{1/n}\right)^{m} \text{ s} \quad (2)$$

where D and B are the depth and width at length L, respectively. For real world systems, it is necessary to provide a setting for the creek/estuary form and this requires an approximate description of the surrounding catchment. This can, in addition, be used to prescribe the form of any river channel, which can also modify the overall form of the creek/estuary. Both of these aspects have been added to the model using a similar approach, defining 3-D forms that correspond to the key dimensions of the catchment/river system using either power or exponential descriptions.

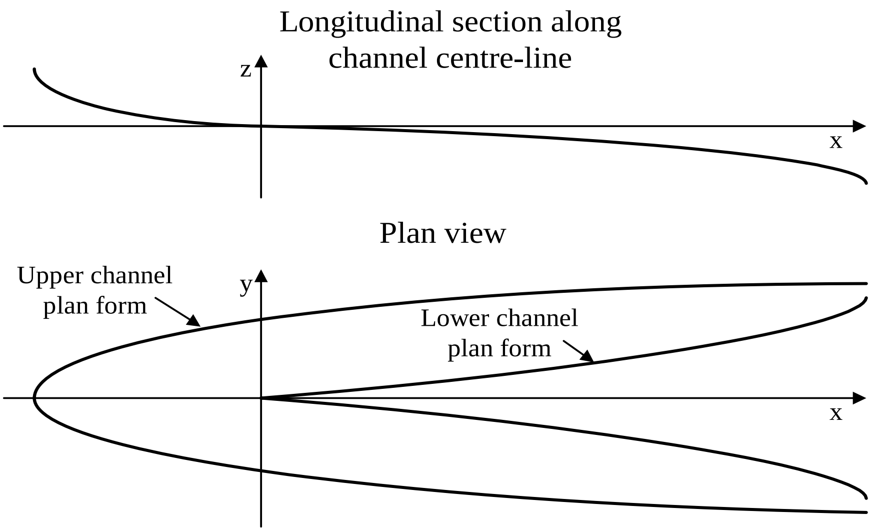

Figure 1. Modelled longitudinal thalweg

This approach forms the basis of the *E*st*F*orm model and is useful for exploring the magnitude of estuary transgression (see Estuary translation), and for the design of intertidal creek systems. It also provides a useful representation for the exploration of analytical and numerical tools.

References

Prandle D, Rahman M, 1980, Tidal response in estuaries, Journal of Physical Oceanography, 10(10), 1552-1573.