Geophysical Research Abstracts,
Vol. 10, EGU2008-A-01161, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-01161
EGU General Assembly 2008

Meander evolution, trajectories and stability: review of approaches, evidence and potential for prediction

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Several different styles of meander evolution have been identified and many different approaches have been taken to analysing and producing methods of prediction of meander change and evolution. A variety of simulation models have also been produced. Difficulties pertain to most of these and no consensus exists on the best approaches or models.

Meanders with very slow rates of erosion or migration tend to change slowly in morphology and tend to be most predictable, particularly as they tend to have the simplest and most regular morphology. The more active meanders tend to have more complex morphologies and for that complexity to increase with rate and age of development. This behaviour conforms well with non-linear dynamical theory.

Although individual components of erosion and deposition vary spatially and temporally, it has been found that overall relations of change to curvature, given a resistance value, produce complex behaviour and therefore the combination of complex processes is being integrated at the bend level. Simple kinematic models are as successful as complex 3d models, as long as the emergent behaviour can be recognised and used as the basis of the model.

Two major problems arise in developing and validating these approaches and models: 1. the selection and number of parameters to adequately characterise the morphology, 2. acquiring adequate time series data of the meander changes.

Plotting of trajectories in phase space offers a method of identification of systematic tendencies in otherwise complex behaviour, providing adequate data are available.