Geophysical Research Abstracts
Vol. 13, EGU2011-6949, 2011
EGU General Assembly 2011

2DStratSim: an efficient source-to-sink model to calculate sediment volumes and forcing propagation

Gerben de Jager, Andrea Forzoni, and Joep Storms
Delft University of Technology, Delft, the Netherlands

The evolution of fluvial, deltaic and coastal marine sedimentary systems through time is dominated by an interplay between eustatic sea level, tectonics and sediment supply. Although the effect of sea level changes is fairly well understood, incorporating tectonic activity and sediment flux is more difficult. For this purpose an efficient forward model has been developed to quantify volumetric changes in sediment distribution in response to allogenic forcing. The short computing time of the algorithm allows for future inverse modeling purposess.

Three-dimensional models are able to calculate volumetric changes but they are often time-consuming to run, whereas two-dimensional models are generally more efficient but do not allow the reconstruction of sediment volumes. Here a model is presented (*2DStratSim*), which performs a rapid 2D down-slope simulation, coupled with an averaging of cross-slope properties to reconstruct changes in sediment volumes.

The model consists of four linked sections:

- Catchment area, where the majority of sediments are derived.
- Floodplain, along which sediment is transported, and potentially stored or eroded.
- Delta-shelf, the main focus of deposition.
- Shoreface-shelf, a wave dominated area where sediments transported by longshore currents can be deposited.

The 1D catchment module is based on the *Paleoflow* hydrological routine (Bogaart et al. 2003) and *BQART* sediment routine (Syvitski and Milliman 2007) which is able to calculate estimates of fluvial discharge and sediment load as a function of climate, tectonics and catchment properties. The floodplain is a newly developed module where sediments can be stored or sourced in response to changes in sea level, discharge, and sediment supply. The delta-shelf and shoreface-shelf are based on BarSim (Storms et al. 2002) and DeltaSim (Overeem et al. 2003), respectively.

Different techniques are used to calculate sediment volumes in the different modules. In the floodplain module the width of the floodplain can be used-defined or estimated based on local sedimentary properties. This width is used to calculate area of deposition, and thereby the volume of the deposited sediments. In the delta-shoreface section volumes are calculated by assuming different delta shapes based on the interaction between sediment supply, tidal effects and wave action. Along the coastline a gradual along-shore change in sediment volume is assumed, based on interpolation between the different profiles in the shoreface-shelf modules.

A comprehensive analysis of the response of the system to allogenic forcing has been performed, where the attenuation of the signal through the system has been evaluated for different regimes, based on sea level, sediment supply, climate and tectonics. The response of the system is examined for varying test cases, such as sand vs. clay dominated systems, large vs. small, frequent flood events vs. frequent storm events. Each type is validated with relevant data from literature.

2DStratSim is shown to accurately reconstruct sediment deposition in response to a variety of forcing signals, whilst also having a high computational accuracy. The short time for generating a model realization allows for future use in an inverse modeling framework (Charvin et al. 2008).

References

Bogaart, P. W., van Balen, R. T., Kasse, C., and Vandenberghe, J. 2003. Process-based modelling of fluvial system response to rapid climate change—I: model formulation and generic applications. Quaternary Science reviews 22: 2077-2095.

Charvin, K., Gallagher, K., Hampson, G. L., and Labourdette, R. 2008. A Bayesian approach to inverse modelling of stratigraphy, part 1: method. Basin Research 21(1): 5-25.

Overeem, I., Veldkamp, A., Tebbens, L., and Kroonenberg, S. B. 2003. Modelling Holocene stratigraphy and depocentre migration of the Volga delta due to Caspian Sea-level change. Sedimentary Geology 159: 159-175.

Storms, J. E. A., Weltje, G. J., van Dijke, J. J., Geel, C. R., and Kroonenberg, S. B. 2002. process-response modeling of wave-dominated coastal systems: simulating evolution and stratigraphy on geological timescales. Journal of Sedimentary Research 72(2): 226-139.

Syvitski, J. P. M.and Milliman, J. D. 2007. Geology, geography and humans battle for dominance over the delivery of fluvial sediment to the coastal ocean. Journal of Geology 115: 1-19.