Research on river bank accretion

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The morphological response of rivers consists of changes of granulometry, bed level variations, as well as erosion and accretion of river banks. Research conducted so far has focused on bed level changes, sediment adaptation and bank erosion, but did not pay attention into bank accretion, even if this process is fundamental for the river channel formation. As a consequence, predicting the river channel adaptation to human interventions and natural changes is still impossible and current process-based understanding and quantitative knowledge of channel morphology are still based on given river widths that are assumed to be known beforehand. Bank accretion is a result of the interaction of several factors as river hydrological regime, sediment transport and morphological changes, riparian vegetation and soil compaction. The latter stabilizes the deposited material, which finally becomes attached to bars and floodplains.

Riparian vegetation is a strong control for fluvial geomorphology not only modifying hydrodynamics, but also acting as an ecosystem engineer who affects sediment and organic matter transport, see Fig. 1a and 1b. The relevance of the reciprocal interaction between vegetation and river morphodynamics has been demonstrated with laboratory experiments and numerical modelling (e.g. Braudrick et al., 2009; Tal and Paola, 2007; Camporeale and Eidolf, 2006; Perucca et al., 2007; Crosato and Samir Saleh, 2011).

This research aims at quantifying the phenomenon of river bank accretion. It includes analytical, numerical and experimental work that will be validated on field and historical data on real rivers, focusing on the role of riparian vegetation Bank erosion and accretion sequences define channels migration, as shown in Fig. 1c, where the clearly defined scroll bars of a meandering channel mark the previous channel banks. Separating the phenomena of bank accretion and opposite bank erosion allows predicting channel response and width adjustment in time and along the river. Preliminary work includes applying a morphological model based on the Delft3D code to analyze the effects of different time scales of vegetation growth and succession on bank accretion and cross-sectional dynamics, considering different hydrological regimes characterized by seasonal, annual and multi-annual cycles. The Delft3D code is based on Baptist's method (Baptist, 2005), which assumes high vegetation density and plants to be represented by thin, vertical and rigid cylinders with uniform properties. The first step of this research is to study the accuracy and validity range of this approach. Based on the agreement with a data set of experimental runs collected from literature by Galema (2009), we studied the performance of the model used in Delft3D by comparing it to other models, obtaining similar results to those of Augustijn et al. (2011). A comparison between the results of the best performing models is shown in Fig. 2.

The model is then applied to idealized river channels in which vegetation of varying characteristics is added following different time schemes. The output will be time variations of the river cross-section, width adjustments and channel formation.

Field measurements are currently carried out in collaboration with the University of Wageningen, Dr. Ton Hoitink and Joris Eekhout, who are monitoring a small stream (The Hagmolenbeek) since September 2010 (Eekhout & Hoitink, 2010).

Future work

The numerical tests will help designing the laboratory experiments that will be carried out at the Fluid Mechanics Laboratory of Delft University of Technology in a 5x50m flume with mobile sediment and plants. This facility will allow performing experiments to simultaneously reproduce bed level changes, bank erosion and bank accretion for given longitudinal channel slopes, discharge regimes and bed sediment compositions, and observe the interaction between the dynamics of opposite banks in sinuous channels.

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Figure 1 Different stages of river migration. a) and b) from Parker et al. (2011) show the stabilization of a point bar by the growth of vegetation and fine material retention. c) from Wikipedia shows the historical locations of banks and scroll bars of a river meander.

Figure 2 Comparison of modelled with measured values for representative roughness in flumes with rigid and flexible vegetation. Methods of: a) Kloostra et al. (1997), b) Van Velzen et al. (2003), c) Baptist (2005) and d) Yang and Choi (2010).
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This research aims at quantifying the phenomenon of river bank accretion. It includes analytical, numerical and experimental work that will be validated on field and historical data on real rivers, focusing on the role of riparian vegetation. Bank erosion and accretion sequences define channels migration, as shown in Fig. 1c, where the clearly defined scroll bars of a meandering channel mark the previous channel banks. Separating the phenomena of bank accretion and opposite bank erosion allows predicting channel response and width adjustment in time and along the river.

Preliminary work includes applying a morphological model based on the Delf3D code to analyze the effects of different time scales of vegetation growth and succession on bank accretion and cross-sectional dynamics, considering different hydrological regimes characterized by seasonal, annual and multi annual cycles. The Delf3D code is based on Baptist's method (Baptist, 2005), which assumes high vegetation density and plants to be represented by thin, vertical and rigid cylinders with uniform properties. The first step of this research is to study the accuracy and validity range of this approach. Based on the agreement with a data set of experimental runs collected from literature by Galema (2009), we studied the performance of the model used in Delf3D by comparing it to other models, obtaining similar results to those of Augustijn et al. (2011). A comparison between the results of the best performing models is shown in Fig. 2.

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![Figure 1](image1.png)

Figure 2 Comparison of modelled with measured values for representative roughness in flumes with rigid and flexible vegetation. Methods of: a) Klooster et al. (1997), b) Van Velzen et al. (2003), c) Baptist (2005) and d) Yang and Choi (2010).

![Figure 2](image2.png)
References


