Evolution of a new tidal river bifurcation: numerical modelling of an avulsion after a catastrophic storm surge

Maarten Kleinhans¹, Henk Weerts², Kim Cohen¹

Inundation was caused by a combination of storm surges, river floods and poor dike maintenance. Here we address:

- How does an avulsion splay develop?
- Is there simultaneous erosion upstream in the feeding channel?

**Biesbosch area, The Netherlands**

**Hypothesis** (Krišle et al. 1998):

1. Antecedent
   - Channel prior to 1421 AD

2. Avulsion, new tidal basin
   - St Elisabeth storm surges and river floods 1421-24 AD

3. Splay/delta, upstream erosion
   - Subsequent evolution tidal basin and upstream river

**Prelim sediment budget 1461-1650**

- Total imported and reworked sediment budget 650x10⁶ m³ (30x10 km, 2m thick, 50/50 sand/mud)
- Splay sediment: 280x10⁶ m³ sand/mud in 200 yr
- Fluvially imported sand: 180x10⁶ m³ = ~600,000 m³/year
- For comparison: modern upstream channel transport rate = ~560,000 m³/year

**Idealised 3D splay modelling**

- deep (4m) / shallow basin (2m) / no basin
- no tides / tides (M2, O1): about 2 m range
- simple basin / antecedent relief
- Engelund-Hansen / Van Rijn

**Reconstructed splay development**

(See van den Berg et al. 2015)

- Initial idealised bathymetry
- Initial bed level (m): 01-Jan-1450 00:00:00
- H 1.2
- Fluvially eroded
- Merwede

**Modelled splay development**

- Delta-like progradation; with bifurcations/avulsion
- Tides affect overall planform

**Conclusions**

- Model agrees with reconstructed splay progradation rates and sediment budget
- Sandy delta progradation faster with tides and in shallow basin
- Entire sediment load of upstream river captured in splay
- No erosion in upstream channel → no upstream impact of avulsion!