Long-term evolution of a morphologically active man-made stream in the Netherlands

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Introduction

Around 1770, a straight artificial canal called Nierscanal has been constructed between the Rivers Niers and Meuse (Fig. 1). The purpose of the stream was to reduce flood risk in the downstream reaches of the River Niers. Whereas the German part of the channel is kept straight throughout time, the Dutch part was left unprotected and developed into a morphodynamically active stream featuring a meandering planform.

Main objective:

Reconstruct and understand long-term evolution of an initial straight channel

Conclusion

- Valley edge and valley bottom profile explain only part of the nonuniform sinuosity development
- A space dependent threshold had to be overcome to initiate meandering of the stream
- Meandering may be triggered by developments in neighboring regions

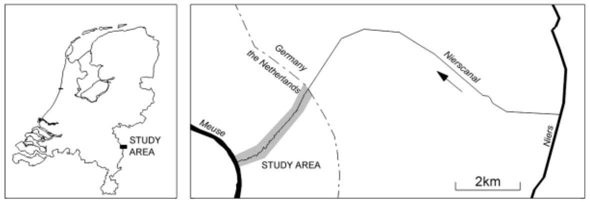
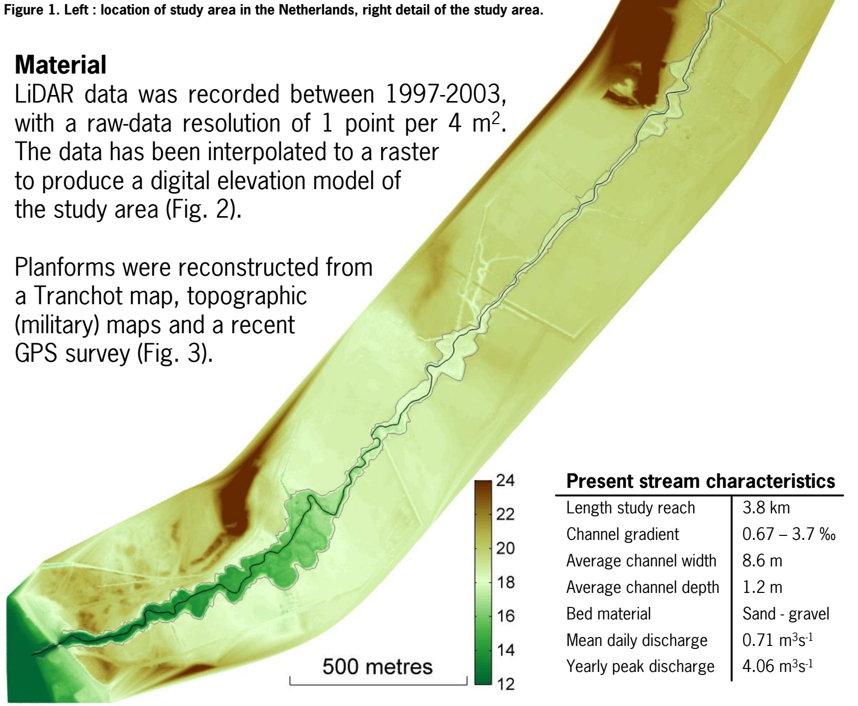


Figure 1. Left : location of study area in the Netherlands, right detail of the study area.

Material

LiDAR data was recorded between 1997-2003, with a raw-data resolution of 1 point per 4 m². The data has been interpolated to a raster to produce a digital elevation model of the study area (Fig. 2).

Planforms were reconstructed from a Tranchot map, topographic (military) maps and a recent GPS survey (Fig. 3).



Present stream characteristics

Length study reach	3.8 km
Channel gradient	0.67 – 3.7 ‰
Average channel width	8.6 m
Average channel depth	1.2 m
Bed material	Sand - gravel
Mean daily discharge	0.71 $m^3 s^{-1}$
Yearly peak discharge	4.06 $m^3 s^{-1}$

Figure 2. Digital Elevation Model of the study area, the colorbar shows the elevation in m+asl. The black line shows the current channel planform, the gray line the valley edge.

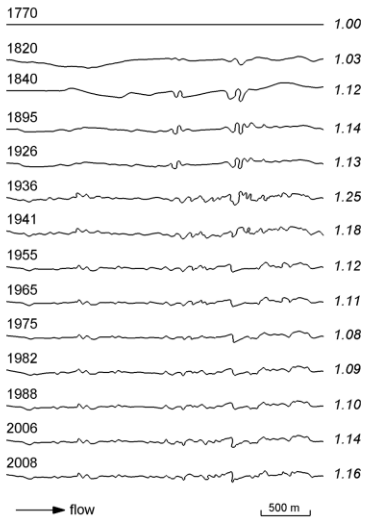


Figure 3. Historical channel planform change since 1820, shown in curvilinear coordinates. Sinuosity values shown in italics.

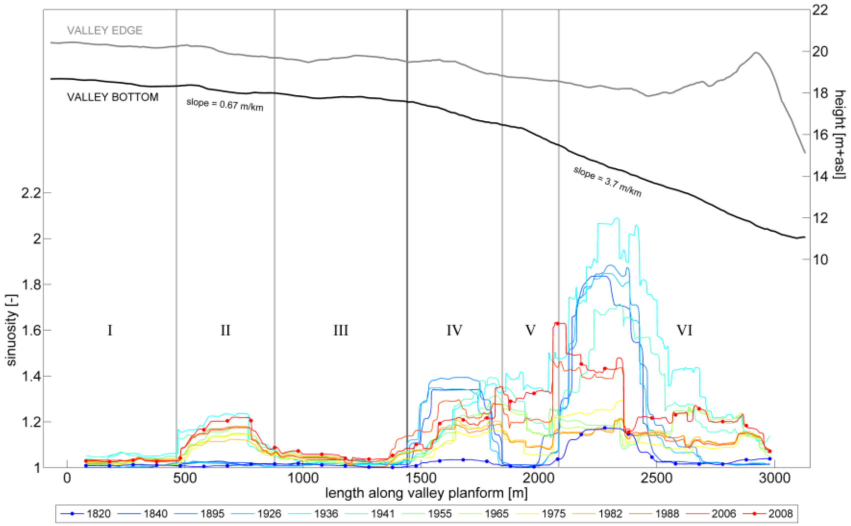


Figure 4. Along valley characteristics. Valley edge (gray line) and valley bottom (black line) are obtained from DEM analysis and correspond with the gray and black lines in Figure 2. Sinuosity (colored lines) are calculated according to Figure 5.

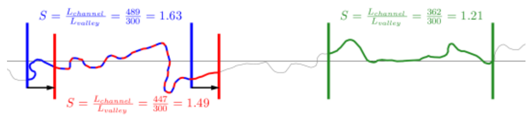


Figure 5. Sinuosity is calculated by dividing the channel length by the valley length (fixed at 300 m). Along the valley length is subsequently calculated at every grid point.

Results

- Lower reach of the channel cuts through an aeolian sand dune, the deep incision of the channel causes lower sinuosity
- Present valley bottom profile appears bilinear, suggesting a state of transition or erosion resistant material at the knick point
- Sinuosity development is initially concentrated in regions IV and VI
- Sinuosity in region II develops abruptly around 1900
- In regions IV and VI both bed slope and sinuosity are relatively higher
- Sinuosity development in region V seems to be triggered by neighboring regions and merges eventually with regions IV and VI

Future work

Find the causes of sinuosity behavior through analysis of:

- sediment and soil characteristics
- details of the present morphometry of the channel and channel belt

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