I.S.RIVERS
LYON 2018

How shipping influences the ecological functioning of man-made side channels in the river Rhine

Introduction

In the river IJssel, smallest of the Dutch Rhine branches, 9 small side channels have been dug for ecological rehabilitation. Beside that, 6 large and deep side channels have been dug for lowering flood levels (Room for the river).This is done by connecting isolated floodplain waterbodies to the river or by digging an entirely new side channel.

Side channel Katerstede with lots of macrophytes and floodplain forest.

Location of the two small side channels in the river IJssel subject on this poster.

Design of side channels in the Dutch Rhine

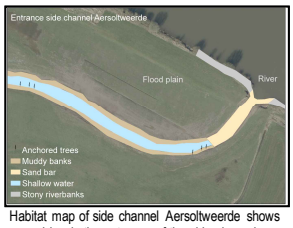
Due to shipping in the river IJssel, the discharge in a side channel has been limited to no more than 1% of the river discharge (on average 3 m^3/s). A higher relative discharge might result in sanding up the main channel too much. Four of the side channels discharge water only during floods and function as backwaters. Six side channels get approximately 1% for 11 months a year. At lower water levels, these channels also function as backwaters. The side channels are designed rather narrow to maintain flow velocity throughout the year. Two side channels are located in wooded environment. In the others, large wood has been anchored in the channels to enhance flow variability and aquatic habitat variation.

Monitoring Method

In one of the side channels (Aersoltweerde) fish were monitored in 2015, 2016 and 2017, macroinvertebrates in 2015 and 2016 and abiotic parameters such as temperature, oxygen, turbidity and chlorophyll-a were monitored in 2015 and 2016. In four other side channels, the monitoring of fish and abiotic parameters started in 2017. Fish was sampled by electro fishing and seine fishing.

Results – Hydromorphology

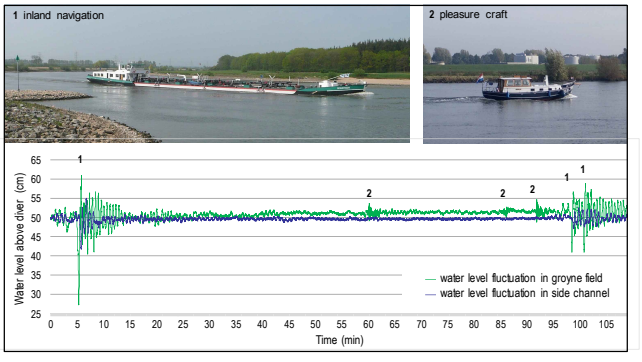
Two years after the construction, a sand bar in the entrance of side channel Aersoltweerde prevents the water flowing into the channel for 50 day/year on average. The bar is about 50 meters long. As designed, the channel is 3 to 10 meters wide at low water level. At average water level, the width is 15 meter. The width of the IJssel at that location is 140 m.



Habitat map of side channel Aersoltweerde shows a sand bar in the entrance of the side channel.

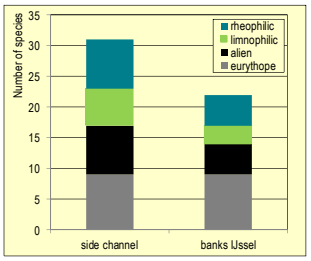
Side channel Aersoltweerde with anchored wood and ripples on the sand bar.

Preliminary results show that hydro-morphology in the side channels is influenced by shipping on the IJssel. The passage of a professional barge results in water level fluctuation in the side channel of up to 13 cm. In the groyne fields however, the fluctuations for the same barge are at least two times larger. These hydrodynamics might have a positive effect on the hydro-morphology of the side channels as flow velocities are higher in the wave-influenced side channel section. As a result, sand dominates the bottom sediment in these sections instead of mud.



Results - Ecology

Compared to the main channel, the species composition consists of more rheophilic young fish species and they are also more abundant in the side channels.



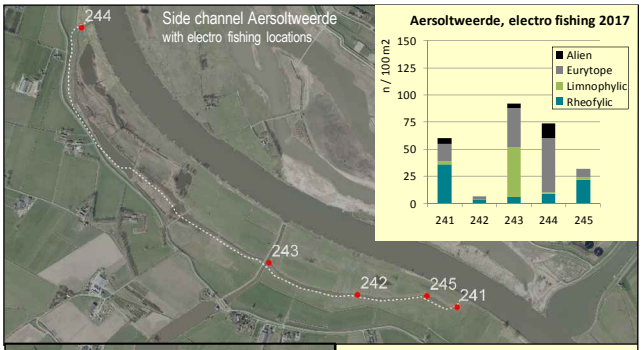
Species richness of fish fauna in side channel Aersoltweerde in 2015 and 2016 compared with river banks IJssel (after Liefveld et al. 2017)

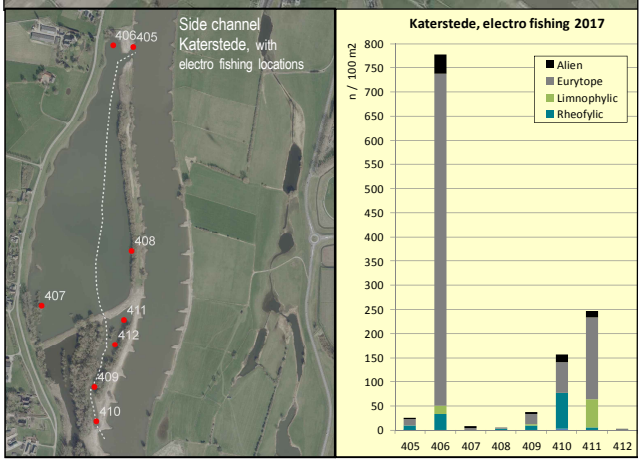
Fish - species richness

In 2017, in each of the 5 monitored side channels at least two of these five rheophilic species were present: Barbel (Barbeau fluviatile, *Barbus barbus*), Nose Carp (*Chondrostoma nasus*), Dace (Vandoise, *Leuciscus leuciscus*), Chub (Chevaine, *Leuciscus cephalus*), and Ide (Ide mélanote, *Leuciscus idus*) In one of these side channels (Katerstede) all five species were present.

Fish - Abundancy

Abundancy differs throughout the side channels. Near the entrance of the side channel, the abundancy of rheophilic fish is higher than in the middle of the side channel. These higher densities may relate to the higher flow velocities near the entrance and the subsequent sandy channel bottom.





Macroinvertebrates

Characteristic rheophilic macroinvertebrates like Yellow-legged Dragonfly (*Gomphus flavipes*) were only found near the entrance of the monitored side channel Aersoltweerde, but are limited in number of species and abundance. This may be related to limited flow velocities or even absence of flow during parts of the year.

Two year classes of *Gomphus flavipes* larvae

Conclusion

By limiting the amount of water that is allowed to be divided from the IJssel, shipping puts a significant constraint on the design of new side channels resulting in very low flow velocities. Nevertheless, these side channels harbor more rheophilic (target) fish species than the main channel. Possibly the reduced dynamics of ship waves in the side channels of the IJssel river unexpectedly have a positive effect on these species by locally reducing the deposition of silt on the side channel bottom.
These are all preliminary conclusions and the study will be continued in the coming years.

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