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.

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 m³/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 and fluctuation in the side channel of up to 13 cm. In the groyne fields however, the water level fluctuation in side channel and groyne fields.

Monitoring Method
In one of the side channels (Aersoltweerde) fish were monitored in 2015 and 2016, 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 days/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.

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 barges 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.

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.

Results - Ecology

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 melanoide, Leuciscus idus). In one of these side channels (Kasterstede) all five species were present.

Fish - Abundance
Abundance differs throughout the year. Near the entrance of the side channel, the abundance 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.

Results - Habitat variation
Large wood has been anchored in the channels to enhance flow variability and aquatic habitat variation.

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