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

Comment la navigation influence le fonctionnement écologique des canaux latéraux artificiels dans le Rhin

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RÉSUMÉ

Dans la rivière IJssel, la plus petite des branches du Rhin néerlandais, 10 petits canaux latéraux ont été creusés pour réaliser une réhabilitation écologique. Cette opération s'effectue en reliant les plans d'eau isolés des plaines inondables à la rivière ou en creusant un canal latéral entièrement nouveau. En raison du fait que l'Ijssel est utilisée pour la navigation, le débit dans le canal latéral a été limité à un maximum de 1 % du débit de la rivière (en moyenne 3 m3/s). Cela a un impact sur la conception des canaux, qui sont destinés à accueillir les espèces rhéophiles. Les sections transversales des canaux latéraux ont été conçues pour être plutôt petites afin de maintenir la vitesse d'écoulement. De gros morceaux de bois ont été ancrés dans les chenaux pour augmenter la variabilité du débit et la variation de l'habitat aquatique. Dans l'un de ces canaux latéraux, les poissons, les macroinvertébrés et les paramètres abiotiques tels que la température, l'oxygène, la turbidité et la chlorophylle-a ont été observés entre 2015 et 2017. Les résultats préliminaires montrent que l'hydromorphologie des canaux latéraux est influencée par la navigation sur l'IJssel. Les jeunes poissons rhéophiles sont plus abondants dans les canaux latéraux que dans le chenal principal. Des macroinvertébrés rhéophiles caractéristiques ont été trouvés près de l'entrée des canaux latéraux, mais le nombre des espèces et leur abondance sont limités. Cela peut être dû au fait que les vitesses d'écoulement sont limitées et qu'il y a même une absence d'écoulement pendant certaines parties de l'année.

ABSTRACT

In the river IJssel, smallest of the Dutch Rhine branches, 10 small side channels have been dug for ecological rehabilitation. This is done by connecting isolated floodplain waterbodies to the river or by digging an entirely new side channel. Due to shipping in the river IJssel, the discharge in the side channel has been limited to no more than 1% of the river discharge (on average 3 m^3/s). This affects the design of the channels, which are meant to facilitate rheophilic species. The cross-sections of the side channels were designed to be rather small to maintain flow velocity. Large wood has been anchored in the channels to enhance flow variability and aquatic habitat variation. In one of these side channels fish, macroinvertebrates and abiotic parameters such as temperature, oxygen, turbidity and chlorophyll-a have been monitored between 2015 and 2017. Preliminary results show that the hydro-morphology in the side channels is influenced by shipping on the IJssel. Rheophilic young fish are more abundant in the side channels than in the main channel. Characteristic rheophilic macroinvertebrates were found near the entrance of the side channels, but are limited in number of species and abundance. This may be related to limited flow velocities and even absence of flow during parts of the year.

KEYWORDS

Fish, hydromorphology, habitat restoration, shipping, side channel

1 INTRODUCTION

In the river IJssel, smallest of the Dutch Rhine branches, 10 small side channels have been dug for ecological rehabilitation. This is done by connecting isolated floodplain waterbodies to the river or by digging an entirely new side channel.

2 DESIGN OF SIDE CHANNELS IN THE DUTCH RHINE

Due to shipping in the river IJssel, the discharge in the side channel has been limited to no more than 1% of the river discharge (on average 3 m^3/s). At a higher relative discharge rate, the main channel is likely to become too shallow. Four of the side channels discharge 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. Two of the side channels are located in forested areas (fig 1 a), the others flow through grasslands (fig 1b). The cross-sections of the side channels were designed to be rather small to maintain flow velocity. Large wood has been anchored in the channels to enhance flow variability and aquatic habitat variation.

Figure 1: a) Side channel Katerstede with lots of macrophytes and floodplain forest.
b) Side channel Aersoltweerde with anchored wood and ripples on a sand bar

3 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.

4 RESULTS

4.1 hydromorphology

Two years after the construction, a sand bar in the entrance of the side channel Aersoltweerde prevents the water flowing into the channel for 50 day/year on average. The bar is about 50 meters long (fig 2). As designed, the channel is 3 to 10 meters wide at low water level. At average water level the width is 15 meter.

Fig. 2 Green coloured laseraltimetrie data show a sand bar in the entrance of the side channel Aersoltweerde.

Preliminary results show that hydro-morphology in the side channels is influenced by shipping on the IJssel. The passage of a vessel is followed by water level fluctuation in the side channel of up to 13 cm. In the groyne fields however, the fluctuations for the same vessel are at least two times larger (figure 3). The entering waves could have a positive effect on the hydro-morphology of the side channels as flow velocities are higher in the wave-influenced side channel section. Sand dominates the bottom sediment in these sections instead of mud.

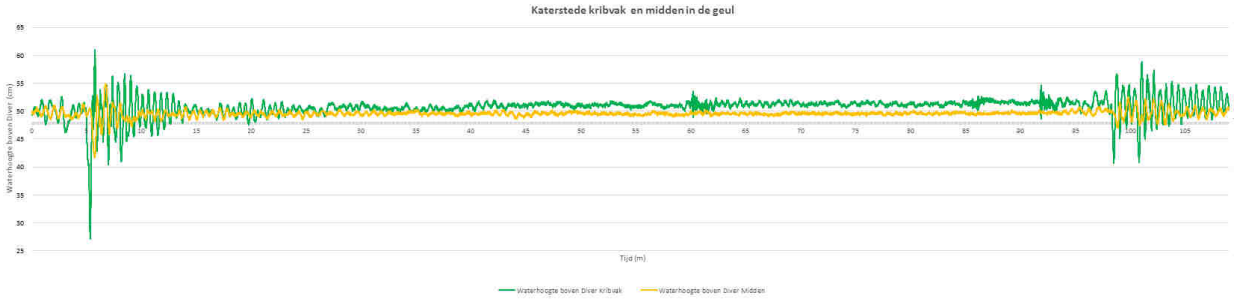
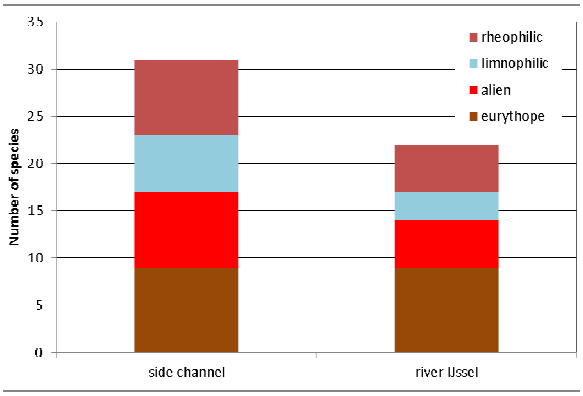


Figure 3 : Water level fluctuations during ship passages on the bank of the river (green) and in the side channel of Katerstede (yellow), 2017

4.2 Ecology

Compared to the main channel, rheophilic young fish is more abundant in the side channels (fig 4a). In 2017, in each of the 5 monitored side channels at least two of the rheophilic species Nose Carp (*Chondrostoma nasus*), Dace (*Leuciscus leuciscus*) Chub (*Leuciscus cephalus*), Barbel *(Barbus barbus*) and Ide (*Leuciscus idus*) were found. In one of these (Katerstede) all 5 species were found.



	Aersoltweerde	Welsumerwaard	Katerstede	Rammelwaard	Reuversweerd
Nose Carp (*Chondrostoma nasus*)	x	x	x		x
Dace (*Leuciscus leuciscus*)	x		x	x	
Chub (*Leuciscus cephalus*)			x	x	
Barbel (*Barbus barbus*)			x	x	
Ide (*Leuciscus idus*)	x	x	x	x	x

Fig 4. a) Species richness of fish fauna in side channel Aersolweerde and river IJssel (after Liefveld *et al.* 2017)
b) Presence of five rheophilic fish species in five side channels (2017)

Characteristic rheophilic macroinvertebrates like Yellow-legged Dragonfly (*Gomphus Flavipes*) were found near the entrance of the monitored side channel, 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.

5 CONCLUSION

By limiting the amount of water that is allowed to be divided from the IJssel, shipping has a limiting effect on the design of new side channels. Nevertheless, these side channels harbor more rheophilic (target) fish species than the main channel. Possibly the dynamics of ship waves in the side channels of the IJssel river also have a positive effect on these species by locally reducing the deposition of silt on the side channel bottom.

LIST OF REFERENCES

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