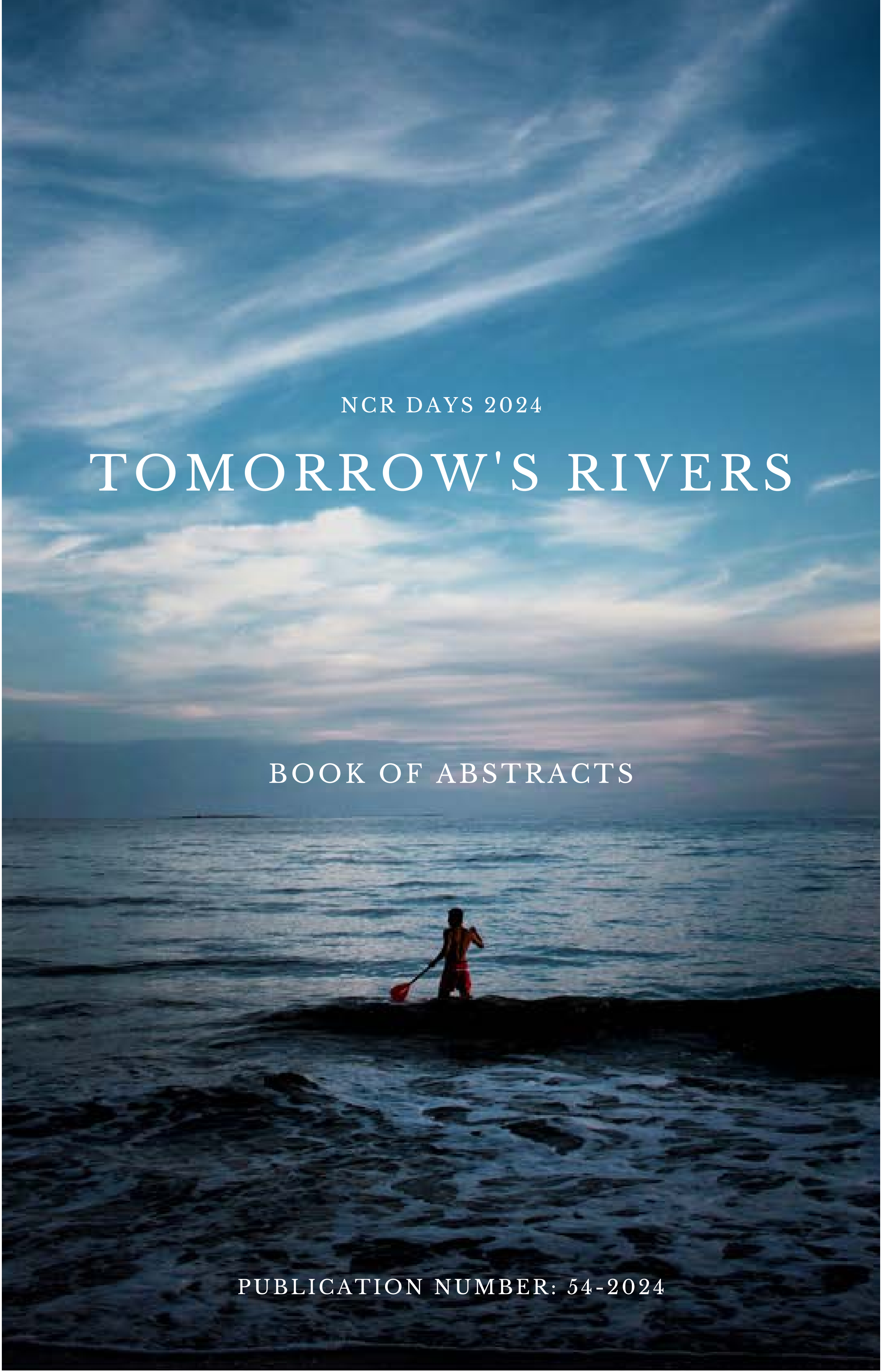

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Morphological development of the Vecht river due to changes in the weir policy

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Keywords — River morphology, morphological modelling

Introduction

The Vecht river, located in Overijssel in the eastern part of the Netherlands, has been canalized over time by cutting of meanders, constructing weirs, and covering the banks with revetments. However, recently river management practices started focusing on the environmental wellbeing of the river system, which resulted in the formulation of a new vision and implementation of measures to rebuild the Vecht into a semi-natural river (Helder et al., 2017). Such a semi-natural river can be characterized by a.o. the presence of meanders and clearly visible morphological processes like sedimentation and erosion.

The current weir policy that is applied in the Vecht is based on maintaining target water levels. A reversed seasonal water level variation is maintained so that water levels are higher in summer than in winter. The weirs also block the flow of water and sediment. This is non-fitting for semi-natural rivers. Implementation of a discharge controlled weir policy is expected to increase the flow through the river and bring back natural seasonal water level variations.

Research about the effect of alternative weir policies on the morphology of rivers is limited (Ni et al., 2021). The objective of this exploratory research is therefore to evaluate the effect of certain changes in the weir policy on the morphology of the Vecht.

Alternative weir policies set-up

With the help of experts from Waterschap Drents Overijsselse Delta and Waterschap Vechtstromen, four different weir policies were formulated. These weir policies are:

1. The current weir policy, a reference scenario in which target water levels are maintained;
2. A discharge controlled weir policy, in which the weir gates are fully opened at a discharge of 50 m^3/s (measured at Ommen) and maintain the original target water levels if the discharge threshold is not met;
3. Same as above but with the weir gates opening at a discharge of 30 m^3/s;
4. Full opening of the weir gates at all times (closest to complete removal of the weirs).

Morphological model set-up

An available 1D SOBEK3 model of the Vecht, covering the area between Emlichheim (Germany) and weir Vilsteren was updated to include recent bed level developments and river interventions such as the construction of new artificial meanders and side channels. The bed roughness along the main channel was calibrated and validated to increase the hydrodynamic accuracy of the model. The morphological calibration parameter α and the median sediment grain size were calibrated and validated based on multibeam measurements of the main channel to increase the morphodynamic accuracy.

As input for the hydrodynamic calibration and validation historical discharge series were used with a duration of several days (for low, medium and high flow), compared to historical discharge series with a duration of nine years for the morphodynamic calibration and validation. The morphodynamic calibration was performed on one weir section (weir Hardenberg to weir Mariënberg), the rest of the river trajectory was used for the morphodynamic validation.

Subsequently the different weir policies were implemented by adjusting the PID controllers of the RTC module. For each weir policy a simulation was performed for a period of 50 years. The nine-year historical discharge series that were used previously were cycled for input. As upstream morphological boundary condition a fixed bed was assumed, since almost no change in the bed level had occurred in the past ten years according to observations.

Accuracy of the model

After calibration and validation the simulated water levels showed a Root Mean Square Error (RMSE) of 15 cm for low and medium flow and

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30 cm for high flow. Deposition and erosion patterns were generally simulated well compared to observations. The simulated bed level change had an RMSE of 40 cm in the calibration section and 55 cm from the validation section. These relatively high values can likely be contributed to the fact that some of the river interventions were done during the simulation period in reality, which could not be reproduced.

Morphological model results

For all weir policies the morphological patterns that were observed consisted of local deposition peaks upstream of the weirs and erosion downstream of the weirs. These changes were mainly initial changes in the bed level, but also long-term changes occurred in the form of erosion and deposition waves that propagated downstream (see Fig. 1 from km 20-35), even though their propagation was partially blocked by the weirs.

Regarding local patterns, the magnitude of deposition peaks and erosion pits was largest for the reference scenario and smallest if all weirs were fully opened at all times (Fig. 2). The propagation of the waves was blocked less if the weirs were opened more frequently. These local patterns agree with existing literature (Ni et al., 2021; Nguyen et al., 2015).

Regarding large-scale patterns, a decrease in deposition upstream of weir De Haandrik was simulated for all weir policies compared to the current weir policy (Fig. 2). Downstream of the weirs a large-scale decrease in erosion occurred for all weir policies compared to the reference scenario, even leading to deposition, which was largest when the weirs were fully opened at all times (Fig. 2). However, these downstream large-scale patterns differ from earlier research, which expected a large-scale bed level decrease (Duró et al., 2022). This difference can be caused by various factors, such as the use of different time scales, but more research is required to pinpoint what exactly causes this different outcome.

Conclusion

This research has shown that the implementation of a discharge controlled weir policy affects the morphology of a river, in terms of local and large-scale deposition and erosion patterns.It can be concluded that opening the weir gates more frequently contributes to the achievement of a semi-natural river, since there is more large-scale morphological activity compared to the reference scenario the more the weir gates are opened, since the flow past the weirs is blocked less.

References

Duró, G., Gradussen, S., & Schippers, M. (2022). Morfodynamiek Overijsselse Vecht, eindrapportage. Deventer, The Netherlands: Witteveen+Bos.

Helder, A. H., & Damsté, P. (2017). De Vecht, uitwerking van halfnatuurlijke rivier. Waterschap Vechtstromen.

Nguyen, V., Moreno, C., & Lyu, S. (2015). Numerical Simulation of Sediment Transport and Bedmorphology around Gangjeong Weir on Nakdong River. KSCE Journal of Civil Engineering, pp. 2291-2297, doi:10.1007/s12205-014-1255-y.

Ni, Y., Cao, Z., Qi, W., Chai, X., & Zhao, A. (2021). Morphodynamic processes in rivers with cascade movable weirs - A case study of the middle Fen River. Journal of Hydrology, https://doi.org/10.1016/j.jhydrol.2021.127133.

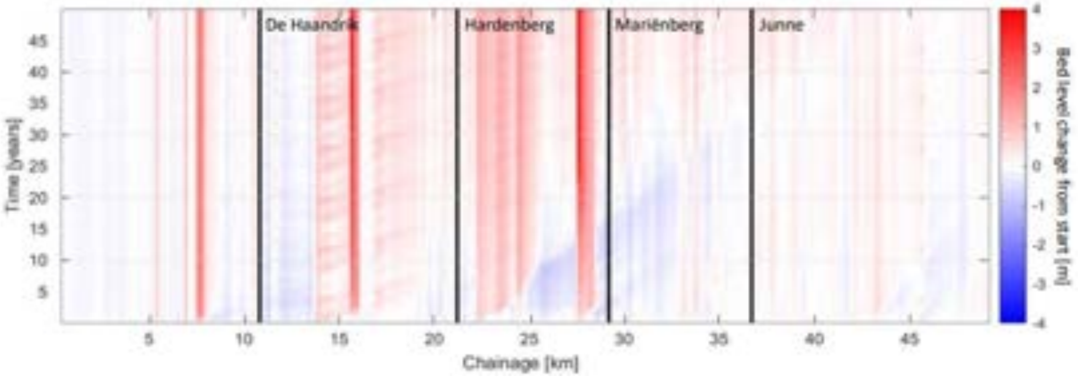

Figure 1. Simulated bed level change in the Vecht for 50 years (compared to initial situation) for the weir policy with all weirs fully open at all times. Positive (negative) values represent deposition (erosion). Black lines represent location of the weirs

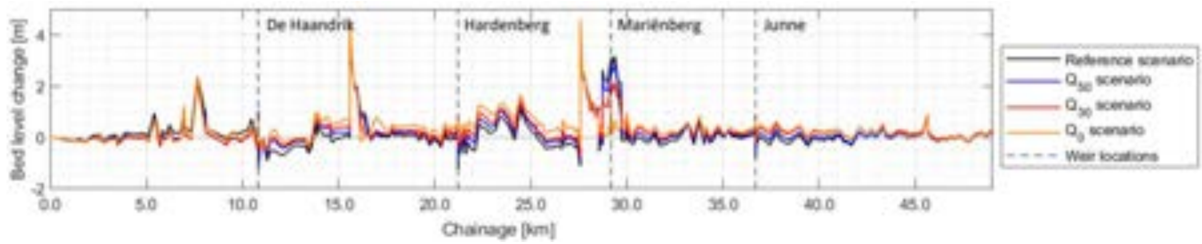

Figure 2. Bed level change of the Vecht for 50 years (compared to initial situation), simulated for the different weir policies

Plastic transport dynamics revealed through flood induced buttertub spill

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Keywords — Plastic pollution, Tracers, Freshwater, Extreme Events

Introduction

Rivers play a substantial role in plastic pollution transport and storage but the transport processes that determine macroplastic fate in the riverine environment are not fully understood yet. Usually it is unknown when and where specific plastic litter items entered the environment, therefore macroplastic transport is often studied via e.g. GPS trackers. However, the July 2021 flood provided an unique opportunity of spilled macroplastic items, with clearly known time and space of emission.

In July 2021 severe floods affected multiple European river catchments, including the Meuse catchment in Belgium. A dairy company located at the Meuse tributary Vesdre was flooded, with parts of their facilities and a lot of material washed away. Among the washed away material was also ~8 million empty dairy packages ("buttertubs"), which have a printed ID code that can be traced to their emission point.

Sampling

During macroplastic sampling immediately after the flood event, and in the following two years, we found 617 of these buttertubs along the Dutch section of the Meuse river (between ~66 to 328 km downstream of the dairy company). We used the buttertubs as tracers for macroplastic transport in the period that includes the flood event, and the following two years.

Transport distance and velocity

Within 20 days of the flood event, some of the buttertubs were transported ~328 km and were found close to the Rhine-Meuse-Delta (Fig. 1). However, the majority of buttertubs was transported less than 100 km within these 20 days, with an average transport distance between 9.75 to 18.25 km/day (Fig. 2). Over the following two years the average transport distance decreased to 0.23

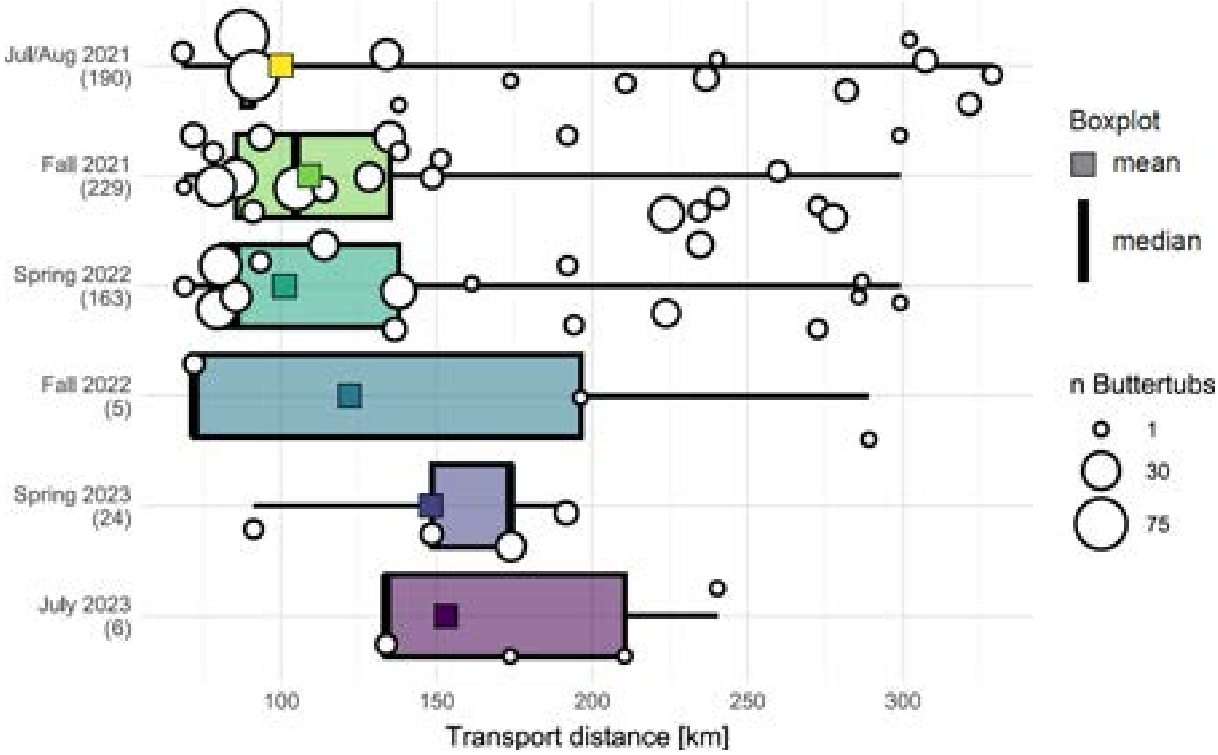

Figure 1. Transport distance of buttertubs along the Dutch Meuse in different measurement rounds. The whiskers extent to the least and furthest found buttertubs, with no regard for the interquartile range (no outliers were defined).

km/day. Which could imply that the buttertubs either were only transported across smaller distances in the following two years, or even not remobilized at all after being deposited during the flood event.

In this unique opportunistic study, we found that the buttertubs mean transport distance moved downstream over the course of two years. The majority of them however, was deposited rather close to their emission point, even given the extreme flood situation.

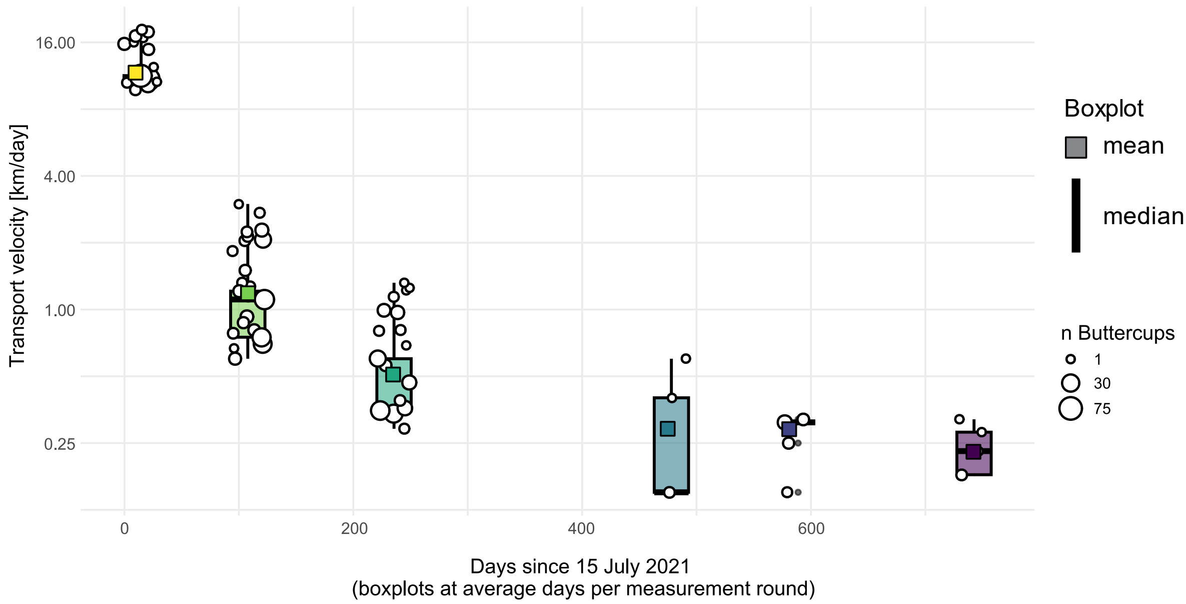

Figure 2. Transport velocity of buttertubs in the Dutch Meuse for the different monitoring rounds.

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