RÉSUMÉ

In recent decades, a large number of secondary channels have been built along the major rivers in the Netherlands. The main goals of these channels are flood protection through water level decline and nature development. The first channels date from the early 1990s, the most recent ones were completed a few years ago. New secondary channels will also be constructed in the (near) future. Rijkswaterstaat initiated an evaluation of the morphology of secondary channels with the study "Grip on secondary channels" (RHDHV, 2019). This study is a follow-up study. In the present study, 10 locations were considered, with a total of 17 secondary channel systems that were identified and analyzed. The research carried out by RoyalHaskoningDHV was mainly aimed at collecting data on the state of secondary channels along the Dutch rivers. In this research, the geometry development has been visualized by comparing bed levels of the initial and final states. As a result, an estimate was made to what extent these secondary channels still meet the requirements for which they were built, and if not, to what extent maintenance is required.

The present study examines the processes behind the observed development of the patterns. This analysis provides insight into what sustainable secondary channel design looks like and how these channels are best constructed, so that they continue to meet the desired goals and make maintenance more efficient. This study therefore results in a set of guidelines that can be taken into account when designing new channels.

In this report, the morphology of the secondary channels is first quantified at macro level and then related to the hydraulic history of the rivers (discharge series). To this end, a bed level and volume analysis was carried out based on bed levels made available. The hydrograph of the nearest measuring station was then placed next to the results in order to find a relationship. The morphological developments within the secondary channels themselves (meso level), which are the result of local processes, were analyzed on the basis of field visits, aerial photos and the aforementioned bed level difference maps.

There are major differences in the length of the analysis period (minimum 3 years, maximum 22 years), the size of the data (the number of available bed level soundings, the number of aerial photos) and the quality of the data. The results show a wide variety of dynamics. Some channels show a lot of morphological activity (Gameren northwest, Ewijkse Plaat, Passewaaij), and others hardly any. The long channel in the Duursche Waarden (constructed in 2015) has never even flowed. The expected frequency of co-flow (when river and secondary channel both flow) is approximately once every 10 years for this secondary channel.

Existing WAQUA results (based on the model 'rijn_j19_5-v1') were used, from which good insight could be obtained into the flow patterns through the channels at various discharge levels. The WAQUA results seem more reliable at high water conditions than at low and medium discharge levels.

At the macro level, it can be observed that almost all secondary channels show a sedimentation trend. An exception is the northwestern channel of Gameren, which has a very high frequency of co-flow and appears to have reached a dynamic equilibrium of the bed. Especially in pools that are part of the channels, (much) sedimentation takes place. Often the pools have existed longer than the secondary channels and are integrated in the design of the secondary channels. In all cases, the degree of sedimentation is of course strongly dependent on the frequency (and the cumulative duration) of co-flow in the channel in question. The aerial photo analysis shows that channels mainly trap sediment during the period when the upstream inlet threshold becomes flooded and the flow velocity in the secondary channels is not yet very high. This will mainly concern fine sediment that settles. During periods of low discharge in the river, where this threshold does not overflow, it has been observed that part of this sludge present in the secondary channels is transported out of the channel. In unilaterally connected secondary channels, the incoming and outgoing water of a ship wave (during periods that the secondary channel/floodplain does not flow) also ensures that sludge is discharged; these can be significant amounts.

At the meso level, morphodynamics can be seen in almost all channels, driven by water level fluctuations (hydrograph, tide, water level drop due to passing ships) and waves (wind, ship waves). This form of morphological activity is strongly determined by how accessible the secondary channel is for water from the river.

How large is the opening, how far can waves of ships penetrate? With a narrow inflow opening (for example an inlet or a narrow bridge opening), the local morphological effects remain limited.

A remaining unknown factor in the analyses is the composition of the sedimentation. Is it mainly sludge or does it mainly involve sediment (sand)? An aerial photo analysis suggests that large-scale sedimentation of sand in the secondary channels last occurred during the January 2003 high water. The sandbanks that have been deposited in a few older channels after this high water, are visible for the first time in the aerial photographs of that autumn and they have hardly changed in size and location after that. In those channels where sedimentation is clearly present, it is recommended to examine the composition by means of soil samples and to repeat this regularly. Based on these examinations, the observed processes can probably be better explained.

Accountability. This research was made possible in part by the Interreg VB North Sea Region project Building with Nature. For more information, see: https://northsearegion.eu/building-with-nature/

This study was financially supported by the EU Interreg VB North Sea Region project Building with Nature.