New algorithms help analyzing river systems

Rivers form an important part of the natural environment. On one hand, they are useful, providing a source of drinking water and enabling transportation. But on the other hand, they can cause natural disasters such as flooding. By building levees and dams, the flow of a river can be influenced. To effectively do this, it is crucial that we properly understand the river’s behavior. Fortunately, nowadays a wealth of data about rivers is available to analyze their behavior: satellite imagery, height measurements, and so on. In his PhD research, Willem Sonke investigated algorithms to analyze river data automatically.

Sonke’s work is especially suitable for so-called ‘braided rivers’: rivers with many islands, around which the water splits into separate channels. An important tool in the analysis of braided rivers is the so-called river network: a drawing consisting of points (which indicate where the river splits and merges) with curves between them (which indicate channels). A river network can be used to compute statistics about the river, such as the length and depth of channels, which help understanding the river’s behavior.

While algorithms for computing river networks exist, they generally do not work well on braided rivers. Therefore in existing research, river networks are often drawn by hand over satellite imagery, which is laborious and error-prone. Sonke developed an algorithm that computes river networks for braided rivers automatically, based on a heightmap of the terrain. A team of geomorphologists from Utrecht University, led by Maarten Kleinhans, has already used our new algorithm in an analysis of the braided Waimakariri River in New Zealand, and the Western Scheldt in the Netherlands.

Another important aspect of braided rivers is that they are dynamic. They can structurally change over time, by moving islands, creating new islands, or eroding away existing ones. It is therefore useful to be able to track parts of the river over time. In other words, if we have height data for several consecutive months, you want to be able to investigate which islands moved, appeared, and disappeared throughout this period. Sonke investigated this problem and constructed an algorithm for a simplified version of it.
Easy-to-read
Besides these results on creating river networks, he also investigated methods to better understand networks, by generating easy-to-read drawings of them. When drawing a large network with conventional automated methods, the drawing generally becomes very wide and not very tall. This results in drawings that do not fit computer screens at all, so you need to pan and zoom to see the drawing. Sonke proposed a clearer way of drawing networks by folding them into rows, and provided an efficient algorithm to compute such a folding.