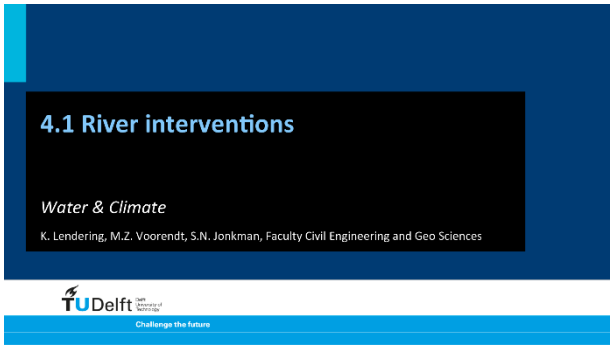
CTB3300WCx – Introduction to Water and Climate

IN1 – River Interventions

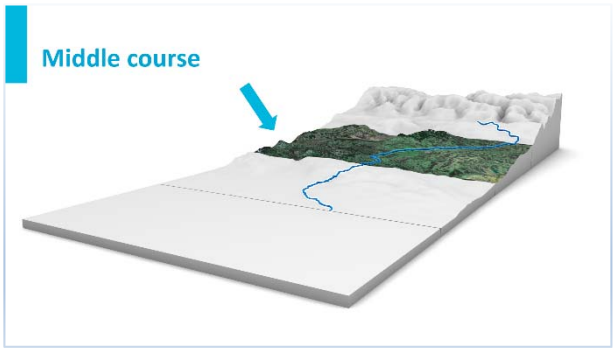
Kasper Lendering



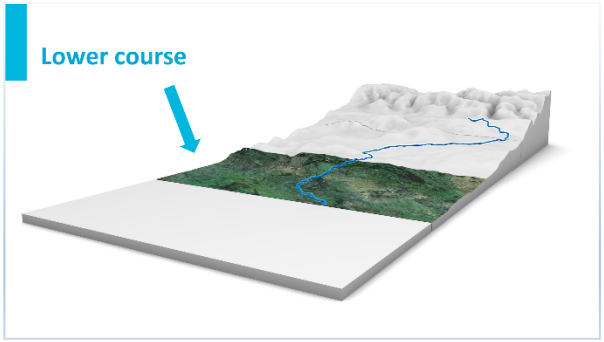
Hi my name is Kasper Lendering. I am a researcher in hydraulic engineering.

This sub module will discuss typical interventions in a river system. The river Rhine, shown in the animation, will be used as a basis to explain all types of interventions in different areas of the river. The river flows from the Swiss Alps, through Germany to the Netherlands where the river mouth flows in to the North Sea. As was explained in the 'Water systems module', a river can be divided in three sections:

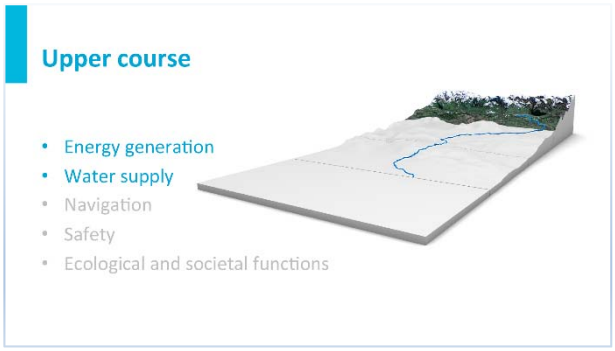
the steepest upper course,



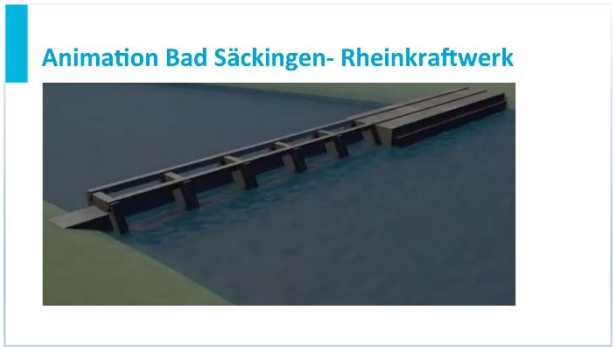
the middle course



and the least steep lower course.

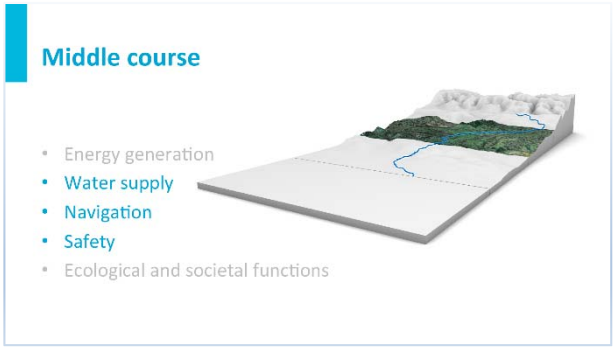


The following module will discuss typical interventions in all sections of a river system. The upper course of the river typically lies in mountainous and hilly areas, where the river collects water from rainfall runoff and snow melt. Due to the rapid runoff of heavy rainfalls, flash floods can occur for people that live in these areas, sometimes in combination with landslides. For these areas a good flood warning system is important. Land cover is an important determinant of the runoff. In areas where vegetation is present, runoff to the river will be delayed by vegetation. Vegetation increases the infiltration capacity of the subsoil, which reduces the runoff. This slows down the flow to a river and delays or spreads out flood peaks. However, this does not have any effect on the magnitude of flood waves in rivers further downstream, because vegetation and the subsoil are soaking wet under those conditions.



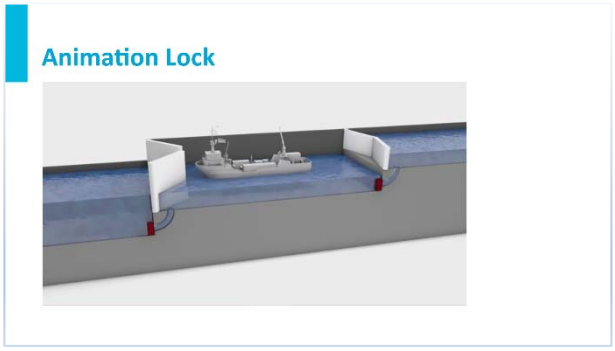
In many rivers hydropower dams are built in upper courses of the system, which is shown here in the Rhine. Here the river is steep so that large head differences can be created. This means that large amounts of energy can be generated in a cost-effective way. Other functions of large dams are the collection of water for irrigation and/or drinking water supply. A disadvantage of dams is that they change the river system, for example by trapping sediment behind the dams, causing changes to ecosystems. A trade-off between these positive and negative effects has to be made in the consideration of new dams. Measures such as sediment nourishments and fish channels or fish stairs are available for mitigating some of these negative effects.

This is the Sackingen hydropower plant. A dam with a flow rate of 1450 cubic meters per second, and a capacity of 74 mega watt. On average, this dam produces 500 gigawatt hours per year, which is enough to provide 150 000 households of hydropower energy.



In the middle course of the river the steepness decreases and flow velocities in the river become smaller. Navigation and flood risk management related interventions gradually become more and more important as we get closer to the river mouth. For navigation purposes weirs and locks are built.

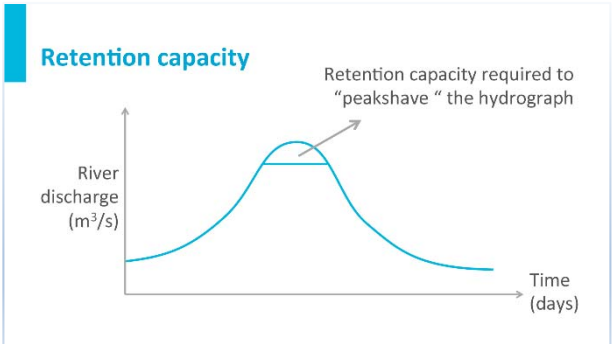
Weirs are structures across rivers designed to reduce the discharge of water downstream of the weir to maintain a minimum depth upstream of the weir. During high river discharges they are overflown to avoid floods upstream of the weir. Navigation locks are structures which can raise and lower vessels between stretches of water with different water levels.



The main elements of a lock consist of a chamber with gates between the upstream and downstream side of the waterways. Once a vessel is inside the chamber, the gates are closed and water levels are adjusted to the upper or lower part of the waterways. In the middle and upper Rhine, locks can be found adjacent to dams, weirs and junctions between rivers and connecting waterways.

Groins in rivers are used to avoid ice jams, and to maintain stable channels with suitable depth for navigation. They do so by constraining the main flow to the central part of the river. These groins can be found all along the course of the Rhine, already starting from the northern most part of the upper course. For the river Rhine, these groins have improved navigability on the short term, but on the long run, they deteriorate navigability, which is a serious river management issue in the Netherlands.

Now we focus on the lower part of the river. In these regions the surface level of the land is often relatively low compared to average mean sea level and river water levels. High river discharges could potentially lead to flooding of these areas. Flood defences are therefore built to protect these areas from flooding. In order to evaluate the risk of flooding it is important to have information on: Flood hazards, for example the probability of occurrence of high water levels due to river or coastal flooding. Also, the presence and performance of flood defences is important, as well as, typical consequences in case of flooding. Flood risk is often defined as the combination of the probability of flooding and the consequences. Several measures can be applied to reduce this flood risk.

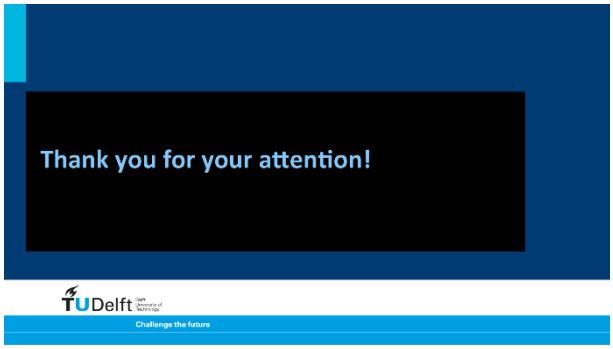


Retention (or storage) areas can be used to store floodwaters and to "peakshave" the hydrograph, which shows the amount of river discharge over time. Since extreme river flows are very large often thousands of m3/s very large areas are needed to lower the water level. Retention is therefore often used in middle or higher parts of the river to reduce extreme discharges.

Another important strategy is to increase the discharge capacity of the river. This can be done in various ways. A river works just like a highway. If there are bottlenecks, jams will occur. At these locations river bypasses can be created to give the river more room. Also, when there is space, additional canals and river branches could be integrated in the landscape to increase discharge capacity. Further, obstructions in the river bed or between flood defences can be removed which allow more discharge to flow through.

In the Netherlands, the room for the rivers project was started to increase the discharge capacity of the Rhine at several locations along the river. For example here, the flood defences have been set back 350 meters to increase the discharge capacity and lower water levels by 35 centimeters. That is an effectiveness of 0.1 centimeter head-decrease per meter setback.

The previous measures can lead to lowering of water levels during floods. However, in most low-lying river and delta areas flood defences are still needed to safeguard people and societies from flooding. Flood defences are earthen or hard structures whose primary objective is to provide protection against flood events; these are treated in a separate clip. Climate change can affect existing or future interventions in several ways. Due to higher temperatures rivers change from glacial to fluvial rivers. Retreating glaciers would expose more material for erosion and supply to the river system. Higher rainfall intensities can lead to higher river discharges and thus vulnerability for flooding. Furthermore, high rainfall intensities can cause larger flash floods in the upper courses of the river and in urban areas. In the lower part of the river sea level rise affects flood safety and salt intrusion in the delta. The future climate change is not well known, and time will tell. Nevertheless some margins for sea level riseand increasing river discharges are taken into account in the design of new interventions in rivers.



Thank you for your attention.