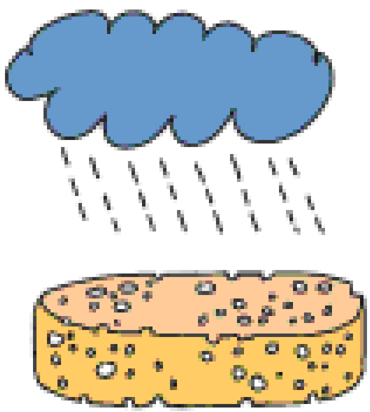
Possibilities for storing water?
Stores of possibilities!

Climate Change will lead to increased occurrence of heavy rainfall and prolonged periods of drought in the river basins of the Rhine and Meuse and will increase the risks of floods and droughts. So far, measures for maintaining the safety levels in a changing climate have been focused on the river itself and the adjacent flood plains. This has resulted in enormous investments in the downstream sections of the river basins such as the comprehensive 'Room for the River' Programme in the Netherlands and more traditional measures like strengthening dikes.

An alternative way of reducing flood risks is by increasing the natural storage capacity within the upstream section of the water system. This might also help to tackle problems of low water and drought by delaying the discharge through a continuous release of water over a longer period of time.

River basins could be seen as huge sponges which provide buffer capacity for retaining water. Human intervention in the river basin can actively increase or reduce this capacity. Traditional agricultural methods focused on drainage have been reducing this capacity for decades. Growing urbanisation and an increase of impermeable man-made surface area have also contributed to a reduction of this 'sponge capacity'.



Source: www.ruimtexmilieu.nl

A promising way of creating increased storage capacity in a river basin is by restoring soil and ground water storage capacity, as well as through water retention in surface water, e.g. pools and channels. This can be done by reintroducing more natural and extensive forms of land use in strategic parts of the river basin.

How does it work?

Natural storage will be most effective in the low mountain ranges. This part of the river basin receives a great deal of precipitation and hence plays a crucial role in the build up of flood peaks. Moreover, many water bodies have been heavily modified to increase the drainage capacity in this region. For this reason the region provides great opportunities for retention.

In principle water transport across the slope consists of three components: overland flow, throughflow and baseflow. Water always chooses the 'way of least resistance' and in most cases this involves infiltration into the ground and transport through the ground in the form of throughflow. A few days later the water will reach a small stream, brook or river: the streamflow. The crux of decelerating discharge is to decrease the intensity of the rapid components (e.g. streamflow) and to increase the intensity of the slower components (e.g. throughflow).

Misled by the models?

Models often show a limited effectiveness of increased retention due to the fact that drainage is not taken into account in the design of the model. The most popular model for hydrological simulations in river basins links a precipitation-discharge model with a hydraulic three-dimensional wave model. In this design the additional buffer capacity is simulated by means of changes in land use only. Hence, the outcomes of this model show very limited effectiveness of the buffer capacity. Models should use a combined intervention (change in land use AND change in the drainage situation) in order to effectively simulate the buffer capacity of a river basin. However, these models are not readily available.

Land use affects the infiltration capacity of the ground. In general it can be said that grassland, shrubs, woods and other vegetation increase infiltration. However, the main player is drainage. The throughflow component is intercepted by the channels and discharged to the streamflow at an accelerated rate. Additionally, at the bottom of the slope, where the ground water is close to the surface, drainage can also draw off the ground water, which then results in an additional proportion of the slow throughflow being converted into a more rapid overland flow and streamflow.

Therefore removing channels and drainpipes from the foot of the slope plays a crucial role in reducing the speed of discharge of water from the entire slope. On the one hand this means that a small adjustment in this area slows down the flow of the entire slope. On the other hand it underlines the fact that change of land use alone is not enough; restoring `sponge capacity` will also require a change in the drainage situation.
In other words: minor interventions in small areas can make a big difference in slowing down the discharge of the entire region.

Too expensive?

Natural water storage in the low mountain ranges is likely to be more cost effective than interventions further downstream. As we have seen in the diagrams, a small adjustment at the foot of the mountain slows down the flow of the entire slope. Therefore, the change would not involve large areas of land. The example of the Dutch 'Room for the River' Programme underlines the cost effectiveness of this measure. The 'Room for the River' Programme in the Netherlands aims to increase the capacity of the Dutch river system by 6.66% with a budget of €2.3 billion. If the Netherlands had spent this amount of money on buying agricultural land in the German low mountain ranges, they could have acquired twice as much land as they needed in order to achieve the same effect on flooding. Moreover, this would also have benefitted the German section of the Rhine which would have meant costs could have been shared.

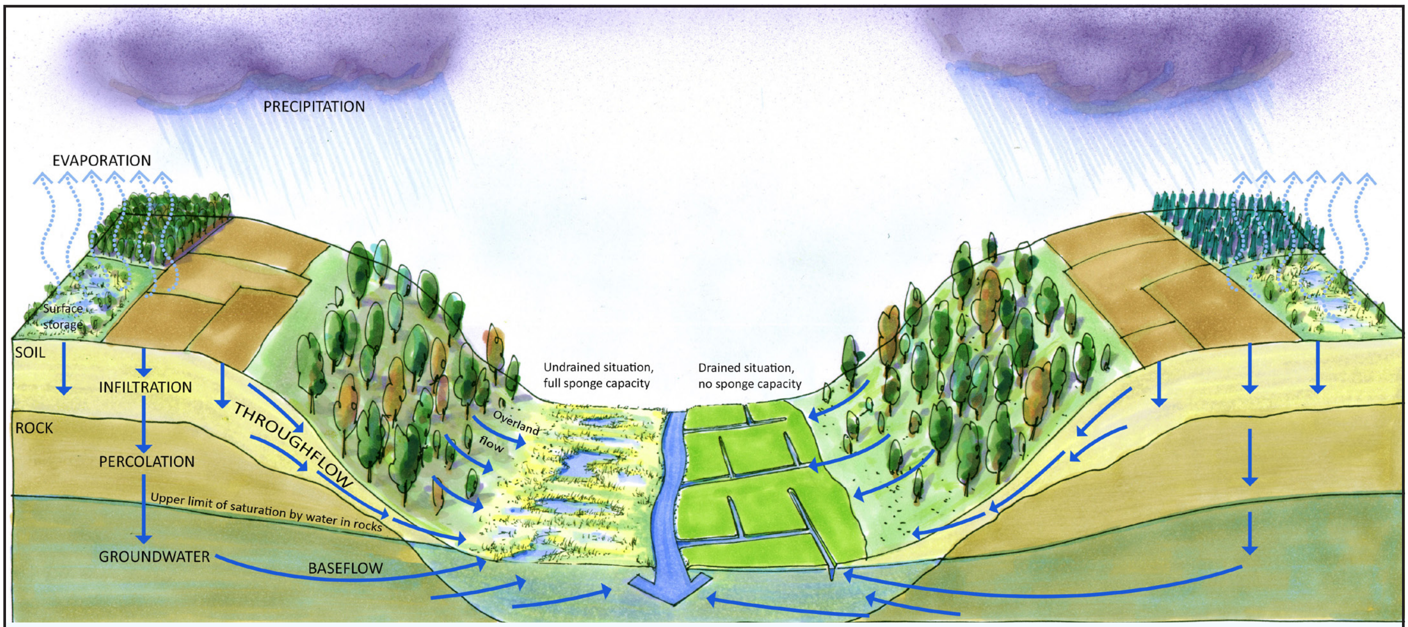


Figure 1. The role of drainage at the foot of the slope. On the right hand side the valley is drained by means of channels, on the left hand side the undrained situation.

The example of the river Gulp

By definition the buffer capacity of a river basin is the quantity of precipitation minus the discharge. This can be represented using the simple formula:

$$\Delta S = I - O$$

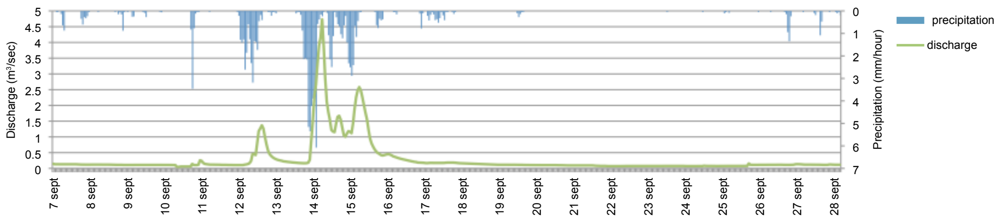
ΔS = *change in storage,*

I = *import into the system (precipitation),*

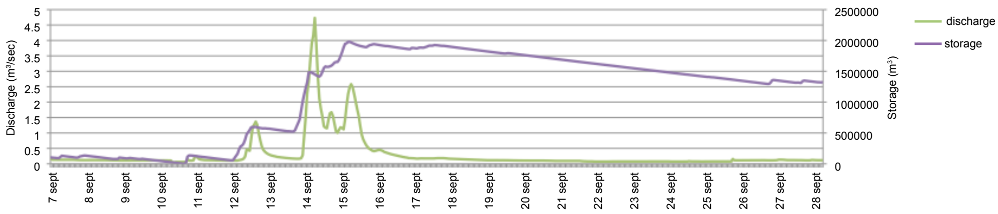
O = *export from the system (evaporation and discharge)*

Visualization of this formula in a graph shows the real capacity of the buffer:

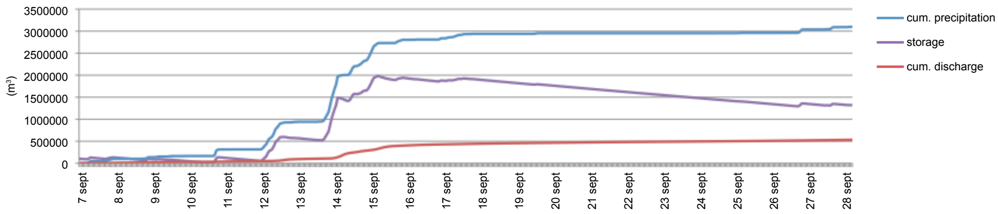
1 *The first graph shows the relationship between precipitation and discharge for the small river basin of the Gulp in Limburg in the Netherlands (28.5km²) during a fairly wet period with intensive rainshowers*



2 *The second graph shows that only a small proportion of the precipitation is discharged immediately, while the river basin as a whole stores an enormous quantity of water.*



3 *From the third graph it becomes clear that the greatest proportion of the precipitation does not discharge immediately but is buffered somewhere in the sponge within the basin and is released over a longer period of time.*



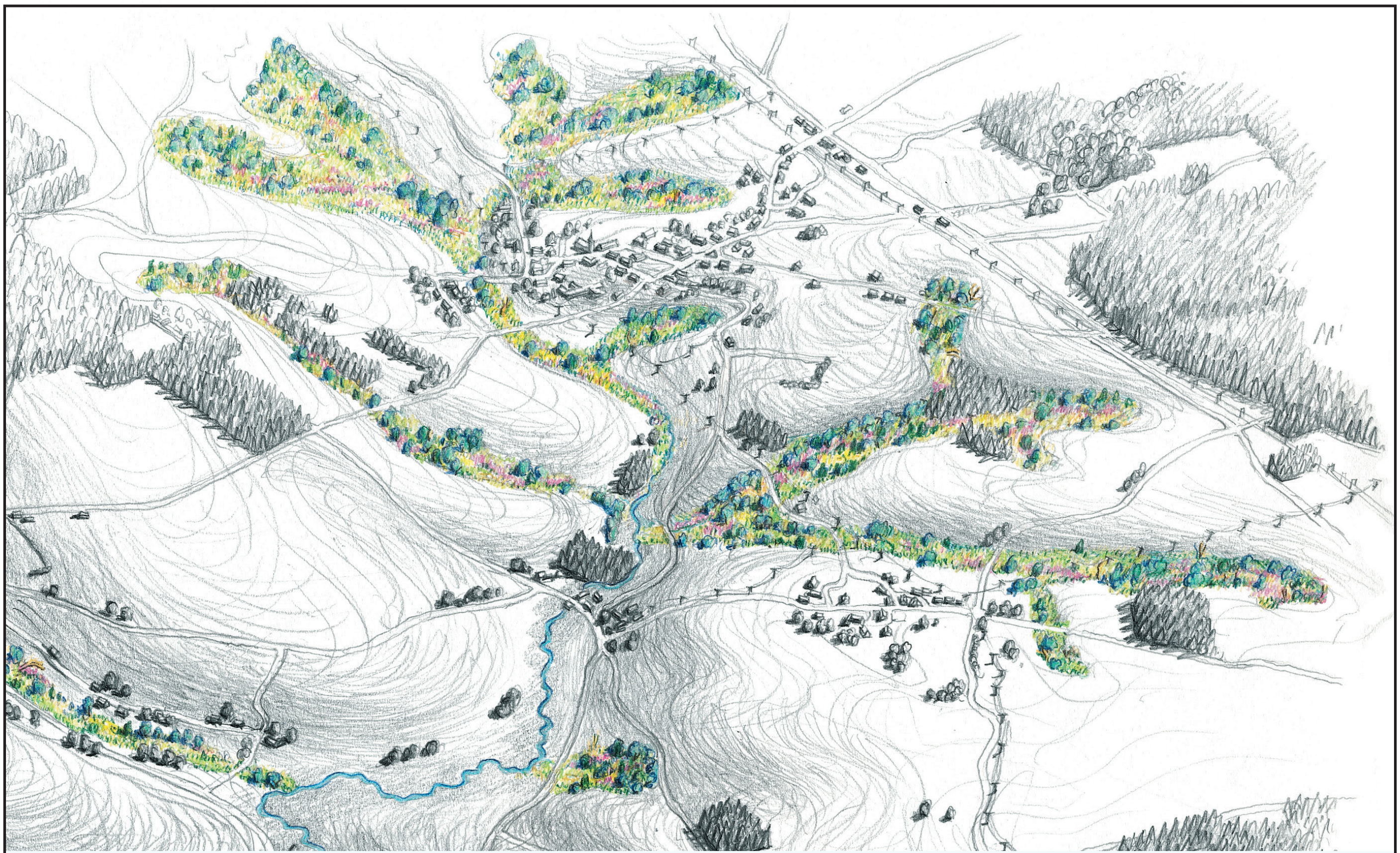


Figure 2. Change in the drainage situation in a small area can make a big difference in slowing down the discharge of the entire region, while the rest of the land can continue to function as before. By focusing specifically on the possibilities of water storage, nature reserves can contribute to water management objectives and such water management measures in their turn can contribute to environmental objectives. (ill. by Jeroen Helmer)

Our ambition

We believe that retention and natural storage in the river basin are promising measures to reduce flood risk. Relatively small interventions in small areas can make a big difference in slowing down the discharge of an entire river basin if both land use and drainage situation are taken into account. Additionally, these measures have other environmental and socio-economic benefits such as offering a new perspective for inefficient agricultural areas.

Call for Pilot projects

At this stage we are certain that natural storage does work. However we are unable to quantify the exact effectiveness; there are no suitable models and insufficient data. Therefore our recommendation is to start up a programme of pilot projects to gain experience with natural storage and to set up monitoring systems in order to gather the necessary data and measure the exact effectiveness.

About us

'Stroming', a consultancy firm for nature and landscape development based in the Netherlands, has developed this concept of upstream water storage commissioned by WWF Netherlands and the Dutch Climate Buffer Coalition. Carthago is an expert in modeling the relationship between climate and hydrology and scrutinized the scientific basis for the concept. The next step involves finding partners to start projects in the field. Stroming has also introduced this concept in the Rhine Corridor initiative; a coalition in the Rhine basin with: Aqua Viva – Rheinaubund, BUND / Rhine Working Group, European Rivers Network, Institute for Geography and Geoecology, Natuurmonumenten, Platform Biodiversity Ecosystems and Economy, Staatsbosbeheer, WWF France, WWF Netherlands and WWF Switzerland. Rhine Corridor aims to strengthen and future-proof the significance of the Rhine as the hydrological, ecological, economic and social backbone of Europe.

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