Vulnerability of villages in the Dutch Geul valley

Do we have to search for solutions within the water systems or floodproofing exposed livelihoods?

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Introduction

In July 2021, several European countries were affected by floods, including the Netherlands. The hotspot of damages in the Netherlands was located in the Geul valley. A first estimate by ENW shows damages of 200-250 million euros in the Dutch part of the Geul valley, which is about 50% of the total estimated damage in the Netherlands (Task Force Fact Finding hoogwater 2021, 2021). Historically, villages along the river in the Geul valley have to deal with floods and the associated risks. There are several urban centres along the Geul river and the inhabitants, buildings and infrastructure are vulnerable to floods (see figure 1). At the same time, urbanization often results in bottlenecks in the water system. Water and surrounding livelihoods conflict, but do we have to search for solutions within the water systems or floodproofing exposed livelihoods? In this abstract, a brief perspective of vulnerable inhabitants and bottlenecks in the water system is given. These are preliminary analyses and the objective of the broader research is to find effective measures to reduce flood risks in the Geul valley by using an integrated risk-based approach.

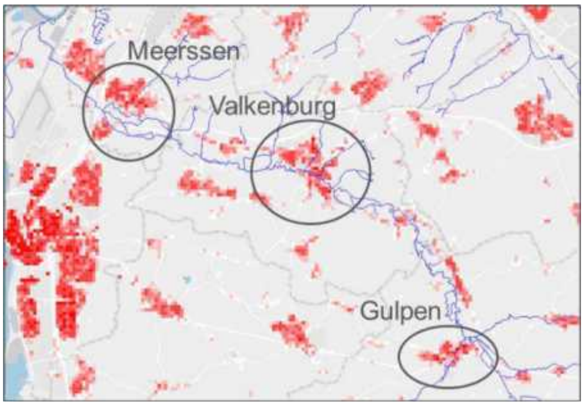

Figure 1. The Geul river and the villages that lay along the Geul are indicated in red. The redness indicates the density of the inhabitants.

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Landscape perspective of vulnerability

To understand flood risk, we first quantify the vulnerable inhabitants in the Geul valley. Therefore, we make use of the height above the nearest open water combined with population data from CBS. Rennó et al. (2008) developed a quantitative topographic algorithm called HAND (Height Above Nearest Drainage). The application of the HAND descriptor is often used in hydrological modelling to classify different landscapes. This algorithm is implemented in the PCRaster and the HAND can be calculated based on only an elevation map, for instance, the AHN3. The present-day landscape of the Geul catchment is characterized by large, flat plateaus and deeply incised river valleys. These characteristics are visible in the distribution of the HAND (see figure 2). Within the valley, there is a large area with HAND values lower than 2 meters. The shape of the curve indicates the presence of floodplains that can inundate. In these lower areas, inhabitants are also settled (pink in figure 2). About 15% of the population in the Geul valley lives in areas with HAND values lower than 3m. We compared the vulnerable inhabitants according to the HAND analysis with the exposed inhabitants estimated by the Task Force Fact Finding hoogwater (TFFF) 2021 (red in figure 2). It can be seen that about half of the vulnerable inhabitants is barely affected by the summer floods, including the village Gulpen.

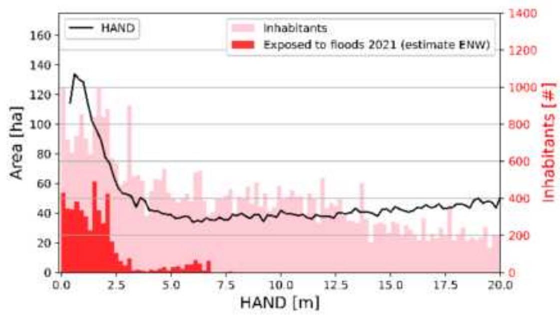

Figure 2. The black line shows the surface area of the HAND values in the Geul valley (left y-axis) and the pink and red bars show the distribution of the inhabitants by HAND (right y-axis). The stepsize of the HAND on the x-axis is 0.2m.

Bottlenecks within the water system

The Geul river is a nearly undisturbed water system without embankments or canalization (de Moor et al. 2008). Klijn et al. (2018) proposed a method to assess the sensitivity of embanked rivers to discharge uncertainties. They expressed this sensitivity by the relationship between discharge and flood water level and quantified this by taking the difference in flood levels for subsequent discharge levels which differ by a factor of 10 in probability of occurrence. This measure is called the decimate or decimation height. The decimate heights in the Geul valley are calculated by using a hydrodynamic model which includes the inundation of floodplains. The decimate height is based on the 1:100 and 1:10 per year exceedance probability. Note that the corresponding discharge levels during the summer floods exceeded the 1:100 per year probability of occurrence and the severity varied along the different branches. The decimate heights along the unbanked Geul river show the presence of urban areas and obstacles like bridges that causes remarkable differences in the robustness along the river (see Figure 3). The river has limited room for flooding when it crosses villages, like Mechelen and Schin op Geul, where high decimate heights are found. Figure 4 shows an aerial image of Schin op Geul in which the decimate heights along the river are indicated by the coloured points.

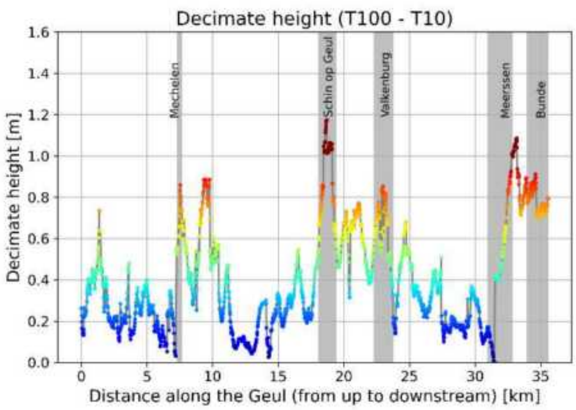

Figure 3. The decimate height along the Geul river. Several villages located along the Geul are indicated by grey areas. The colours correspond to the decimate height. Other branches in the catchment (Gulp, Selzerbeek and Eyserbeek) are not shown.

Future research

Appropriate design of the water system and the surrounding environment and the search for effective measures are necessary to protect livelihoods from floods. Conventional measures primarily focus on reducing the water levels by improving the water system (e.g. more room for the river or changing the rainfall-runoff process). The flood risk hotspots arise at places where rivers cross villages and space is being used by several spatial functions.

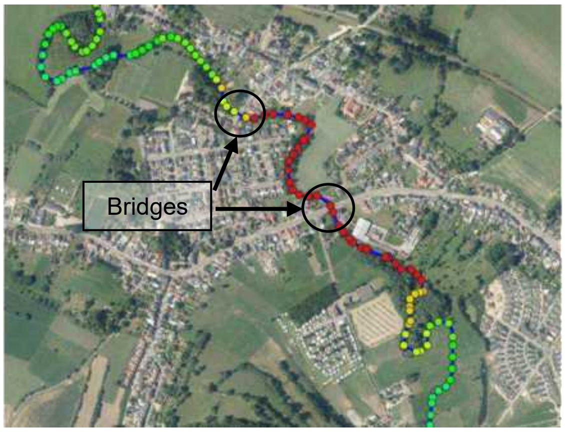

Figure 4. The decimate height at Schin op Geul. Two locations where bridges crossing the river are appointed. Red corresponds to large decimate heights and green to lower ones, like indicated in Figure 3.

It may be difficult to give more space to the water systems and other types of measures can reduce flood risks as well, like temporary and emergency flood-proofing. What are effective measures to reduce the flood risks in the Geul valley? As always, without humans, there is no risk. So, it would make sense to reduce flood risks by making livelihoods themselves more flood-proof or flood resilient, e.g. by reducing damages and improving flood recovery to get back on their feet more quickly. How to compare the effectiveness of different risk reduction strategies and what is an effective strategy to protect the village Valkenburg?

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