Developing low flow strategies for the Albert canal and the Campine canals

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Introduction

Low flows are a natural phenomenon of water systems, caused by the seasonal nature of the rainfall-runoff-evapotranspiration processes in the catchment of the water system. Water shortages, on the other hand, are human-induced phenomena that occur when the natural water system is unable to provide enough water to fulfil the water demand in the socio-economic water chain, depending on this water system.

Due to the fact that the water demand of different aspects of the socio-economic water chain has been (and still is) rising during past decades, it can be expected that the impact of water shortage will have an ever increasing impact on society.

What follows is a synthesis of several assignments that belong to Flanders Hydraulics' covering project "fresh water management against shortages and droughts" and focus on the system of the Albert canal and the Campine canals. Detailed information can be found in the documents listed below.

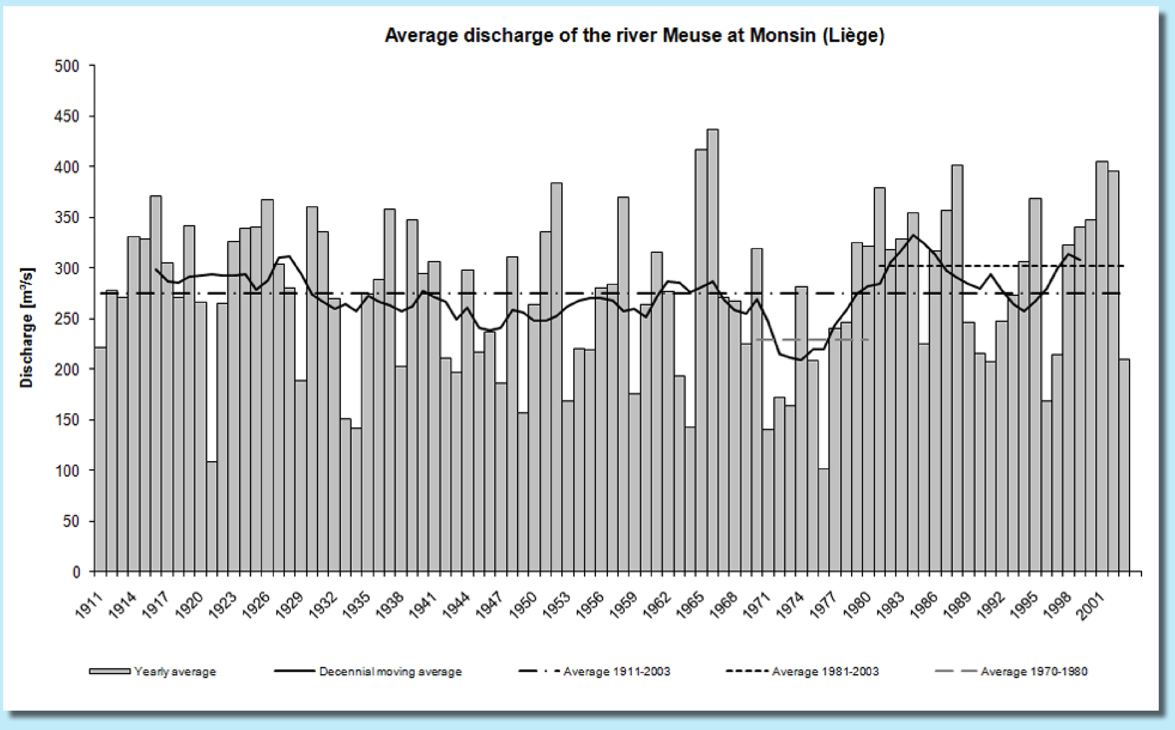

Figure 1. Yearly average, all-time average and 10-yearly progressing average discharge of the Meuse at Liege (Monsin), 1911-2003.

Methodology for the development of low flow strategies

In a primary stage it is necessary to gather as much knowledge and data about the system under study as possible. This inventory forms the basics for the identification of actors and stakeholders, but also serves as an input for the modelling tools that need to be developed.

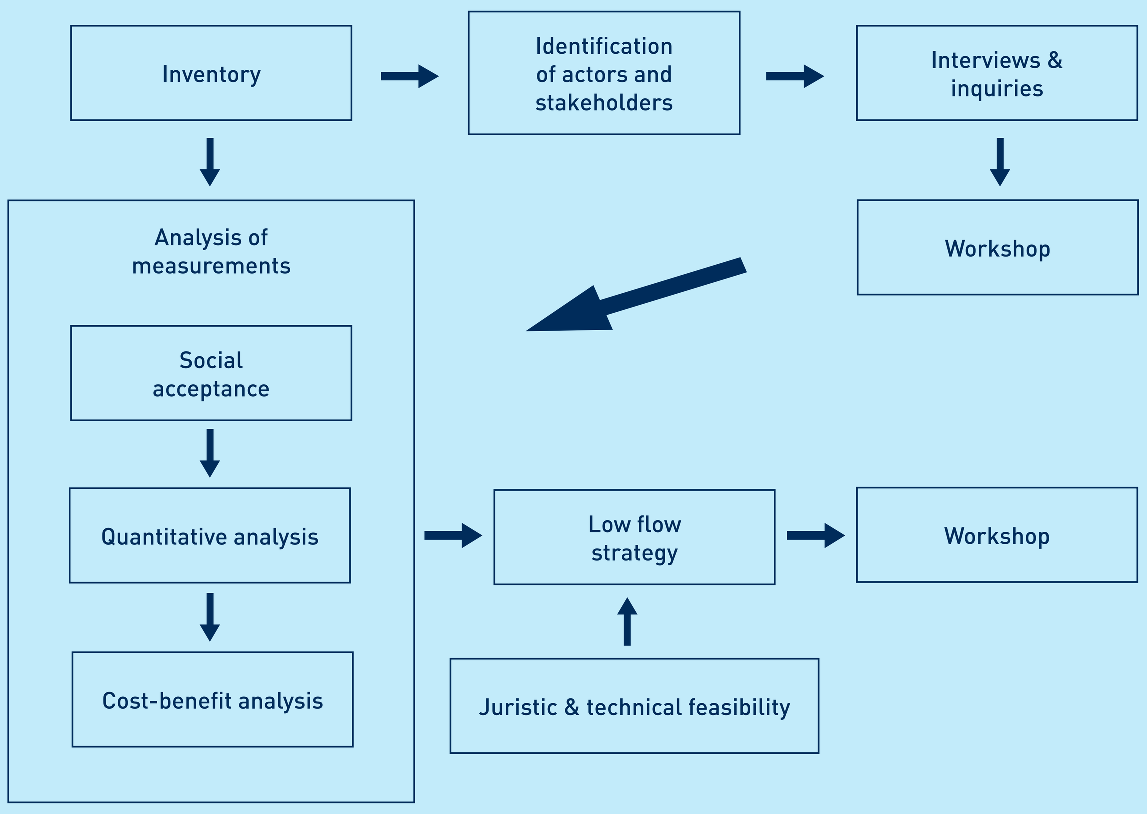

Figure 2. Methodology for the development of low flow strategies

Through interviews and inquiries the magnitude and variation of the water demand and the impact of measure on the identified actors and stakeholders could be assessed. To assess the effect of a certain measure or set of measures on the water chain a set of modelling tools had to be developed. Applying these tools, it was possible to study the effects of applying a certain strategy on the occurring damage and non-quantifiable effects. By testing different alternative strategies on their effects it is possible to develop a strategy in which the negative effects of water shortages are greatly reduced.

References

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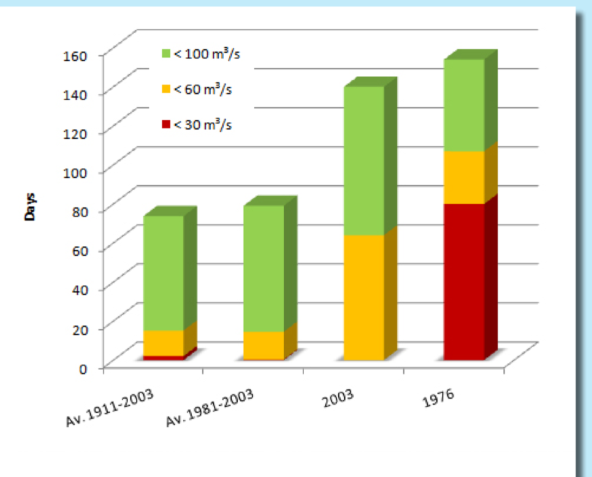
Variability of the Meuse discharge and boundaries for water shortage periods

As depicted in Figure 1 the yearly average discharge of the Meuse at Monsin varies from year to year. The mid 1970's were relatively dry compared to the last 20 years, with the year 1976 containing the longest and lowest low-flow period ever registered. Compared to this kind of drought, the summer of 2003 seems like just a minor foretaste.

In 1995 the Flemish and Dutch authorities signed an agreement on how to distribute the available water between both regions during periods of increasing water shortage. These discharges can be considered as boundaries below which water shortages occur in the system of the Albert canal and the Campine canals.
In Figure 3 the number of days where the discharge was below these boundaries, on average for the period 1911-2003 and in particular the years 2003 and 1976.

When water scarcity occurs a crisis plan or low flow strategy is needed where different kinds of measures, like reduction of abstractions or adressing the available drinking water reserves, can be taken. However, the severeness and order of the possible measures determines the damage to the society. Therefore it is necessary to investigate the effects of the severeness and order of all possible measures in different alternative low flow strategies.



Discharge [m³/s]	Number of days below critical discharge			
	Average 1911-2003	Average 1981-2003	2003	1976
100 (Alert)	90	88	172	237
60 (Alarm)	31	23	96	190
30 (Crisis)	2	0,4	0	92

Figure 3. Number of days below critical discharge on average for the period 1911-2003 and for the particular years 2003 and 1976.

Modelling tools to develop low flow strategies

To assess the effect of a certain measure or set of measures a water distribution (allocation) model of the canal system, which extracts its water from the Meuse, was set up. This model is a representation of the canal system in which all water users (navigation, industry, drinking water, electricity, agriculture, nature, tourism and recreation) with their time-dependent and variable water demands are described. MIKE Basin was used as a starting base but, as it turned out to be insufficient for this kind of study, was rapidly extended with VBA modules. With these modules it was possible to hold the socio-economic layer fixed on the year 2002, while the hydrological and meteorological circumstances (i.c. the water system) could vary (e.g. 2003 of 1976).

The water demand of irrigated agricultural land was calculated using a separate modelling software (IRSIS) of which the results were integrated in the model.

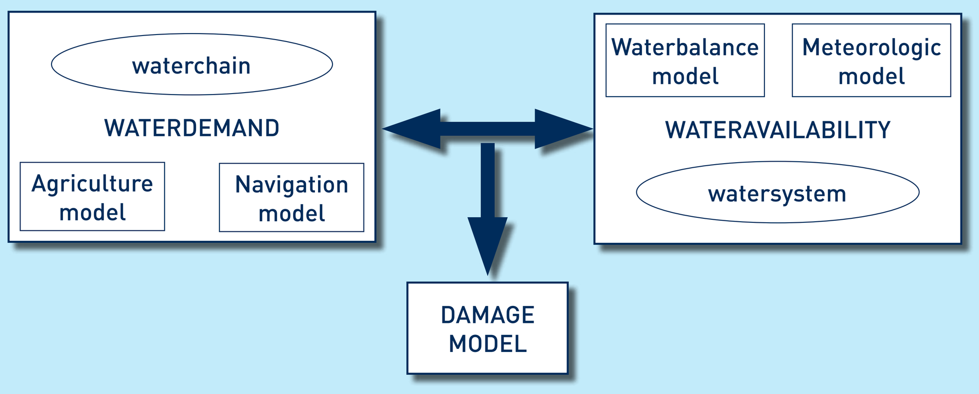


Figure 4. Modelling tools applied for the development of low flow strategies

For the effects of certain measures, like the quantitative and economic effect of grouped lockage of vessels, it was necessary to develop a separate (navigation) module and run subsequent simulations.

For each user a damage function was developed, based on which a cost-benefit balance of a certain measure or set of measures could be determined. Also non-quantifiable effects like possible loss of ecological values.

The combination of these 3 criteria (water quantity, cost-benefit balance and non-quantifiable effect) leads to the selection of the most beneficial strategy.

Development of alternative strategies

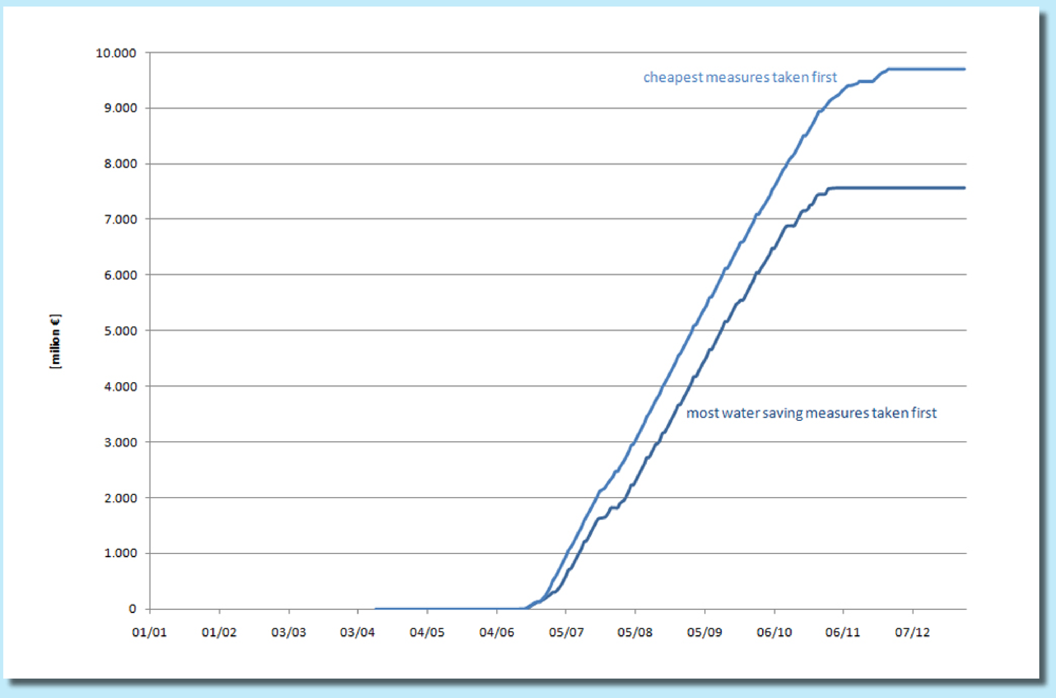


Figure 5. Total damage applying strategies based on the cheapest measures and the most water saving measures.

At first different extreme strategies, like first reducing Flemish water demand by taking the cheapest measures first or on the other hand first reducing the biggest water demand. The outcomes of these strategies, as depicted in Fig. 5, are not to be interpreted as definitive strategies, but are more indicative. Additional other strategies are developed and tested by lumping sectors or reducing the occurrence of non-quantifiable effects (like the risk of drinking water depletion).

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