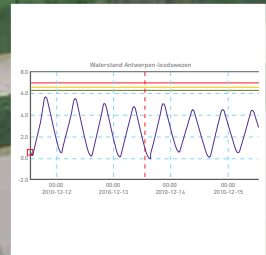


# HIC: the forecasting centre for navigable waterways in Flanders





## Table of contents

■ 1	HIC's tasks	4
■ 2	And it continued to rain...	6
■ 3	Water shortages: a problem today and tomorrow	12
■ 4	Models: essential tools for water management	14
■ 5	From a study model to a forecasting model	18
■ 6	Creating an applicable and up-to-date model: not an easy feat	22
■ 7	From theory to practice: using forecasts	26



Flanders Hydraulics Research in Antwerp





## Foreword

The floods of November 2010 and January 2011 are still fresh in people's memories. Inundated streets, houses and fields; fire fighters pumping water out of cellars; youth organisations spontaneously helping to fill sandbags; citizens trying to keep the water out of their living rooms with all the courage of despair: everyone in Flanders can still recall these images.

Paradoxically enough, problems with low water levels and drought have also started to appear. During the last few summers, ships have had to use locks in groups, the public had been urged not to waste drinking water and agreements from the Meuse discharge treaty had to be applied.

Above all, everyone would like to avoid floods. However, the efforts that would be needed to achieve this are not feasible in practice. In both financial and spatial terms, the costs would be excessive. Both scientists and water managers agree that a combination of measures is needed to limit the damage caused by floods in the future as far as possible. But not all risks can be eliminated. In exceptional weather conditions, certain areas can face the danger of flooding. For these areas, it is important to have permanent information available about water levels and flows, and there is a continuous need for an effective warning and alarm system.

Drawing up predictions for water levels and discharges in the Flemish navigable waterways is one of the tasks of the Hydrological Information Centre (HIC), which is a part of Flanders Hydraulics Research. HIC uses accurate forecasting models fed by the most recent measurements for Flemish rivers, data from fellow river managers in Wallonia, Brussels, France and the Netherlands and meteorological forecasts.



Flooding of the Dender, November 2010

In this way, HIC forecasts water levels and discharges for the next 48 hours several times per day. This data is used by the local waterway managers and processed into high water reports which HIC provides to crisis centres.

This brochure gives you a behind-the-scenes look at HIC's forecasting centre operations. More information can be found in HIC's other brochures or by contacting HIC (contact details at the end of this brochure).



# 1



The HIC-team

## HIC's tasks

The Hydrological Information Centre (HIC) is a research group that offers scientific support for the management of water levels on the Flemish navigable waterways. To do this, HIC not only cooperates actively with the waterway managers but also with other institutions in Flanders and elsewhere that deal with ground and surface water – because water knows no borders!

### 1.1 A SINGLE KNOWLEDGE AND INFORMATION CENTRE FOR NAVIGABLE WATERWAYS

HIC centralises all time-related data that is important for Flanders' navigable waterways. It develops models that can simulate the flow behaviour of the navigable waters and adjusts them where necessary, follows international developments in the field of hydrology, performs hydrological studies and gives management advice to all stakeholders. In short, HIC is the central knowledge and information centre for water level management on the Flemish navigable waterways.

### 1.2 SCIENTIFIC SUPPORT FOR WATER MANAGEMENT PLANS AT FLEMISH AND EUROPEAN LEVEL

Floods cannot be stopped, but they can be managed. With the Water Framework Directive, Flanders is committed to transposing European decisions into local policy. The European Floods Directive requires flood risks to be assessed for specific locations and measures to be taken to limit the damage as much as possible. HIC supplies reliable mapping information for this purpose. Using it, the water manager can develop an economically and socially acceptable safety policy, based on areas that need to receive maximum protection against flooding, and areas where floods are less harmful or even beneficial.



### 1.3 SCIENTIFIC SUPPORT FOR FRESH WATER MANAGEMENT

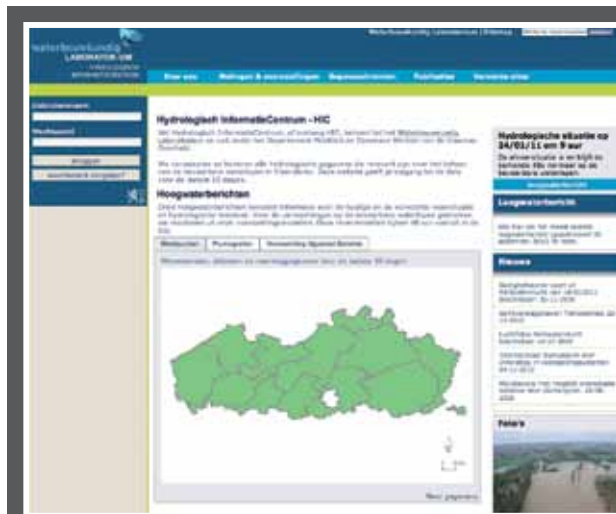
If the flow on our navigable waterways temporarily drops too sharply, this can have direct consequences for the supply of drinking water, shipping, the ecosystem or the availability of process water for agriculture and industry. The influence of climate change can reinforce these effects even more. HIC investigates how water can be used as efficiently as possible during periods of drought and where water shortages can be prevented for the navigable waterways in Flanders.

### 1.4 DAILY HYDROLOGICAL FORECASTS

In crisis situations, HIC supplies forecasts of the expected water levels and discharges on the navigable waterways up to five times per day, and indicates where emergency conditions will be most acute if flooding is imminent. Water managers and crisis centres can then adopt targeted measures.



Flooding of the right bank of the Dender downstream of the Denderleeuw lock complex, November 2010



HIC website: [www.waterstanden.be](http://www.waterstanden.be)

# 2



Water level gauge on the Demer at Aarschot

## And it continued to rain...

Around the turn of the century, Flanders regularly faced heavy winter flooding. In more recent years, serious summer thunderstorms have caused the most inconvenience. After a few relatively quiet years, we were once again confronted with sizeable floods in the centre of the country in November 2010.

A new major flow event followed in January 2011, putting the problem of flooding back on the agenda. Yet floods are a natural phenomenon, so trying to avoid them at any cost makes little sense. What we can do is try to minimise the damage that floods cause. To gain greater insight into the complex behaviour of waterways, modern water management relies on scientific models and innovative applications.

### 2.1 FLOODING IN FLANDERS

Flooding and the problems it causes will probably always be an issue. Many remember the floods in the IJzer and Meuse region during the winters of 1993-1994 and 1994-1995. Spectacular downpours brought heavy flooding to the Nete and Demer basin in the late summer of 1998. In the autumn of 1999, large areas of the Leie and Dender region were submerged. Flooding at various locations in Flanders also hit the headlines in late 2002 and early 2003. The Westhoek area experienced summer flooding in July 2005 and again in July 2007. At the end of November 2009, the IJzer region again suffered from adverse weather conditions. The recent 2010 flooding along the Dender and the canal from Brussels to the Scheldt are still fresh in people's minds.

Floods are a natural phenomenon: in extreme weather conditions, rivers need space to dispose of excess rain. However, it seems clear that the harmful consequences of flooding have increased in recent decades. One of the reasons for this is high-density building in Flanders, which is also increasingly being sited close to rivers.

Furthermore, changes in the weather patterns are also expected for the region. The quantity and intensity of rain will change, and the sea level is also expected to rise.

#### FLOODING

A perennial problem



## 2.2 FROM PROTECTION AGAINST WATER TO PROTECTION AGAINST DAMAGE

Up to the end of the previous century, the struggle against flooding was based on the idea that as little land as possible should be flooded. High dykes were built, preferably as close as possible to the river. Flanders and the Netherlands were taken as models for all water-rich countries. New developments in water management have led to a different, more natural view. The starting point is that floods are natural and will always occur, so they are no longer resisted at any price. Instead, minimising the damage takes priority. There are other reasons for this approach, too: complete protection against floods cannot be justified socially or economically.

In many regions, flood damage turns out to be limited. In nature reserves, flooding can even have positive effects. Conversely, floods must be avoided in densely populated areas. Thus flooding needs to be controlled as far as possible, and confined to locations where the damage is minimal.

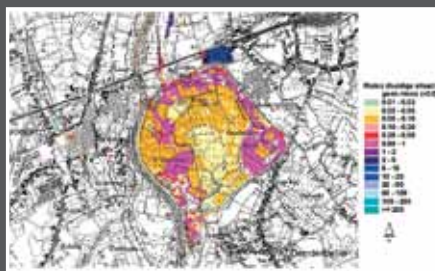
In upstream regions, the problem is tackled at the source by keeping excess water onsite as much as possible. This source-oriented approach principally demands small-scale measures (separating rainwater from the mains sewerage system, increasing infiltration, re-assessing ditches, etc.). We also look for additional buffer capacity in the natural flooding zones along the river. Flood waters are diverted to areas where they will cause the least damage. Additional protection against inundation, such as controlled overflow zones, sluices and pumping stations, is adjusted based on the potential damage.

### LATIS

In the past, when measures had to be adopted against flooding, the focus was primarily on how the area could be protected against high water levels, mainly by raising the dykes. In recent decades, the focus has shifted towards taking measures to reduce the flood risk. The flood risk can be seen as the combination of the damage that occurs at a specific water level and the likelihood that such flooding will occur; it is expressed in Euros per year. In order to determine the flood risk for Flanders comprehensively and uniformly, HIC and the Department of Geography of Ghent University have developed the LATIS flood risk software.

Based on land use data (position of buildings, important 'hotspots' such as schools and hospitals, agricultural areas, etc.) and socio-economic data (house prices, crop values, etc.) this software calculates the potential damage for every location in Flanders. The actual flood damage can then be determined by combining this potential damage with flood maps. This is done using damage functions which reflect the percentage of actual damage as a function of the water depth. Finally, the damage maps for various recurrence intervals can be combined into a single risk map. In addition to calculating economic risks, LATIS can also calculate casualty risks, using modelled inundation speeds and flow rates, in addition to water depth data.

Among other things, the software has been used in recent years to devise the Sigma plan for the tidal zone of the river Scheldt and for the Integrated Coastal Safety Plan, to assess evolving risks due to climate change and to compare alternative infrastructure designs on navigable waterways.



Denderbellebroek risk map



Stilling well with gauge



Rainfall recorder at Denderleeuw



HIC website: [www.waterstanden.be](http://www.waterstanden.be); measurement locations in the IJzer basin

## 2.3 MEASUREMENT IS KNOWLEDGE

For anticipating imminent floods and for forecasting flooding more generally, data from the past is very useful. Through statistical analyses of historical time series, changes in water level and flow rates over time can be made visible. However, for statistical reasons a great quantity of data is needed to estimate risks reliably. The amount of data we have from the past is quite limited. Continuous recording of water levels and discharges began in 1967. Prior to that, measurements were taken more sporadically: for example, the water level was recorded manually once a day. Techniques for measuring water levels and flows on waterways (limnimetry) have progressed considerably over the past 50 years. As a result, much more data is already available digitally from the more recent past.

Today, the HIC limnimetric measurement network registers water levels and discharges at 150 well-equipped measuring stations on navigable waterways in Flanders. This measurement network is being continually maintained, extended and automated. Most of the measuring stations are now equipped with teletransmission: a central module connects with the stations every 15 minutes to collect the data. An HIC hydrologist views the graphs of the water levels and discharges that each measuring post has transmitted every day.

Obviously, the measured water levels and discharges are accounted for by rainfall. HIC therefore operates an extensive measurement network of around 40 rainfall recorders. The measurement network has been extended substantially since 2007 and older devices have been replaced.

### Water level measurements on the web

The measurements for the navigable waterways in Flanders are available to the public via the website [www.waterstanden.be](http://www.waterstanden.be). The available locations are displayed per basin and the data for the past 10 days can be viewed. Professional users can obtain (maximum and minimum) water levels, discharges, rainfall data, coordinates of the measuring stations, Qh curves (with which the discharges can be derived from the water level) and metadata about the measuring station (measuring method, history of the measuring stations, etc.). For questions about these and other matters, they can contact [hic@vlaanderen.be](mailto:hic@vlaanderen.be)

## Data with international significance

Water knows no borders. Substantial volumes of water from Wallonia and France flow into little Flanders. A small portion of this water ends up directly in the North Sea, while the greater part flows on to the Netherlands (the Westerschelde, the Ghent-Terneuzen canal and the Meuse). For a proper understanding of the quantity of water that flows through Flanders, information from neighbouring regions is essential. HIC concludes cooperation agreements with other organisations for this purpose, and real-time data from the surrounding regions is collected at HIC.

### 2.4 THE HIC CONTINUOUS MONITORING SYSTEM: RAPID RESPONSIVENESS

In exceptional weather conditions, certain locations or areas may face the threat of flooding. It is important to have information available round the clock about likely developments in such areas. To satisfy this need, HIC has developed a continuous monitoring system. The occupants of high-risk areas want to know on a timely basis if they are under threat again, emergency services need to be on the spot as quickly as possible to adopt precautions, to limit the damage or to evacuate residents, and waterway managers can take further measures to limit the damage.

Under normal circumstances, a continuous monitoring team carries out verification tasks. A high water report is drawn up three times per day with meteorological predictions, the amount of rainfall over the past days, the hydrological predictions on the non-tidal waterways and the expected water levels at a number of places along the Scheldt. Normally, this high water report is only published on the [www.waterstanden.be](http://www.waterstanden.be) site. In order to recognise situations of concern on a timely basis, alert and alarm levels have been determined together with the waterway managers. Once the alert levels are reached, vigilance is increased and the situation is tracked several times a day.



Daily forecast by the hydrologist on duty

Should the water in a river reach the alarm level, the HIC forecasting centre is continually manned. The frequency of the high water reports is then increased to five times per day.

The information that is available via the measurement network is used together with Belgian Royal Meteorological Institute weather forecasts (rainfall, wind) to produce predictions concerning water levels and flow rates in the rivers. The predictions are compiled by a hydrologist with in-depth knowledge of the behaviour of Flemish rivers.

During these periods of increased vigilance, HIC forwards these predictions to River Information Services (RIS). RIS acts as an information and communication centre in the event of flooding: it informs all of the required services, such as the fire services, civil defence and mayors or governors. The Crisis Centre of the Ministry of Internal Affairs is also informed and in extreme crises looks after coordination, collection of information and dissemination of data to the public. These high water reports are also available on the HIC web page.



[www.waterstanden.be](http://www.waterstanden.be) during a high water period



# 3



The Border Meuse during a low water period, summer 2003



The Border Meuse during a low water period, summer 2003

## Water shortages: a problem today and tomorrow

Despite the wet weather in Flanders, the problem of low water levels on rivers and canals is increasing in frequency. The Common Meuse between Flanders and the Netherlands, the Albert canal and the Kempen canals in particular can face problems due to limited water supply during dry periods. But the consequences of a long drought can also be seen in other rivers such as the Leie and the Upper Scheldt and in the canals that are fed by them. The effects of water shortages are clear, for shipping, but also for the environment, industry and agriculture. Water managers are therefore rightly concerned to optimise their policy and the way they manage water shortages.

### 3.1 WATER SCARCITY IN FLANDERS

Water scarcity is not rare in Flanders. During extremely dry years (especially at the end of a dry summer and in autumn), the water reaches disturbingly low levels in many Flemish rivers. Dry, hot summers exhaust the water reserves in the catchment basin and groundwater reservoirs. This can cause serious water shortages, especially if additions to the groundwater were limited during the previous winter. Furthermore, recent research shows that even longer periods of summer drought can be expected in the future. Combined with increasingly limited groundwater recharge in the winter, this will lead to lower flows during the summer months.

Flanders has concluded a treaty with the Netherlands to regulate the distribution or supply of water during low flows at a number of locations. Treaties of this type exist for the Common Meuse and for the Ghent-Terneuzen canal, and have a high impact on the availability of water in Flanders.

## CONSIDERED CHOICES

Policy support  
from HIC for responses to  
water shortage

As well as being heavily used transport routes, many Flemish waterways also supply water to numerous users: industry, energy and drinking water production, agriculture, etc. Some of the water disappears through evaporation. A substantial quantity of water is needed at locks, to allow vessels to pass through. A certain flow rate is also necessary at a number of places to push back salt water. Finally, water is needed for recreation purposes and to wash away discharged material.

Water scarcity is therefore not a negligible problem for Flanders, and one we will have to contend with even more in the future.

### 3.2 TOWARDS A UNIFORM APPROACH FOR FLANDERS

By preventing water shortages where feasible and using available water during low water periods as rationally as possible, we can significantly reduce the ecological and economic damage caused by drought.

Unlike flooding, a low water situation has the advantage that it is easier to predict and less complex: the water level drops gradually, without sudden peaks or dips. One disadvantage, however, is that low water periods last much longer than high water periods. Otherwise, the approach is the same as for combating high water: it consists of collecting and interpreting all available information to produce forecasts and to warn the water managers in a timely fashion. To an extent, low water management can be practised by limiting extraction, actively managing levels and increasing surface water storage.



Water in the Ghent area

Possible measures include reintegrating the natural wetlands into the water system, using retention ponds, limiting losses at locks and dams, pumping back lock water, exploiting drinking water reserves from reservoirs in dry periods and requiring industry, agriculture and the public to save water. The mathematical models and time series analyses that HIC produces support the water managers in these measures.



Flooding of the Dender downstream Geraardsbergen

## RENEWED APPROACH

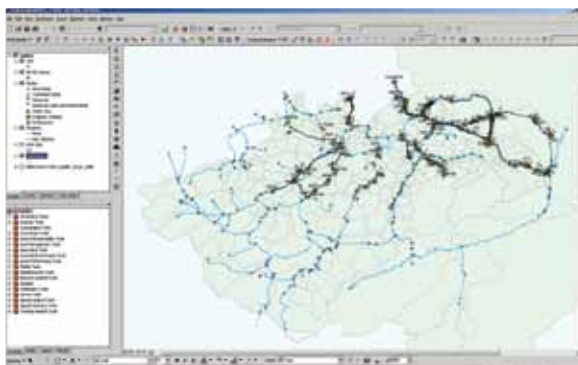
Changes force us to  
consider water shortages  
as well

### Water distribution in the Scheldt basin

To support the adoption of management measures and the making of policy choices, HIC has developed a water allocation model that can evaluate measures during droughts and estimate their impact. The information collected for the construction of the model shows that almost 8.5 billion m<sup>3</sup> of water is withdrawn annually from the main waterways in the Belgian and Dutch sections of the Scheldt basin (and associated canals that pass through more than one catchment basin). This corresponds to an average flow of over 260 m<sup>3</sup>/s. 98% of this is discharged back into the watercourse, while the rest is effectively consumed. Almost 50% of the water that is used is related to shipping: this is the volume used during the movement of vessels through locks. Besides shipping, the energy sector (30%), the industrial sector (13%), the public sector (5%) and the drinking water companies (2%) are the biggest users of surface water.

As might be expected, these users are mainly found around the big industrial centres and arteries: the Zeeschelde, the ports of Antwerp and Ghent and the Albert canal.

A regional model that can be used to simulate the current water distribution in the basin has been developed with this user information and an understanding of the hydrological water supply via the tributaries. In a later phase, in response to information from the waterway managers, it will be possible to study local problems in detail or to use the model for scenario analyses.



Water allocation model for Flanders



## Low water reports

Every year, Flanders Hydraulics Research's Hydrological Information Centre (HIC) distributes monthly low water reports from April to September, or for as long as there is a chance of water shortages. Among other items, these reports contain periodical information on precipitation, river flows and groundwater levels based on the most recent hydrometeorological data supplemented by forecasts for the coming decades. The reports are distributed directly to the water managers and can be viewed by the public on the [www.waterstanden.be](http://www.waterstanden.be) site.



Low water reporting on the website from April to September

# 4

## Models: essential tools for water management

Powerful computer models that can map the flow and flooding behaviour of waterways have existed for many years. HIC has developed such river models for all the navigable waterways in Flanders. Water managers are using the results of these models tailored to individual rivers to seek realistic solutions for high and low water problems in Flanders.

### 4.1 MODELS IN WATER MANAGEMENT

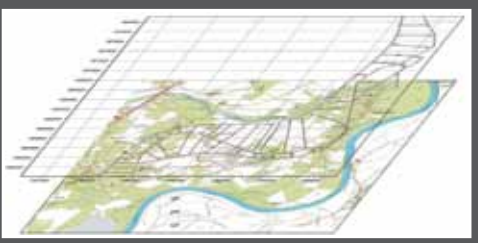
With the development of mathematical models that simulate the flow behaviour of rivers, the possibilities for predicting flooding have expanded significantly in recent years. These computer models have now developed into essential tools for water management.

The computer translates the available precipitation measurements into water levels and flows with formulas, enabling flow behaviour to be simulated and studied. This allows us to issue statements about water levels and flows, and to evaluate what effect a storm of a certain intensity will have on the water level and what the result will be of any intervention that is considered.

In addition to models, aerial photography and radar images are also important tools for water managers. This is because forecasts based on models are only reliable if they use accurate basic data as input, such as the characteristics and dimensions of the watercourse, the flood plain and the adjacent, low-lying (and therefore potentially floodable) zones. Accurate data about the elevation of the terrain is therefore crucial. Together with other government agencies, HIC has therefore commissioned a Digital Elevation Model (DEM) for all of Flanders. This detailed map, created using aerial photography and laser scanning, makes it possible to demarcate potential flooding zones more effectively.

### HIGH-QUALITY MODELS

Good basic data are  
very important



The Dender at Geraardsbergen, November 2010

Digital models to support Flemish  
water management

#### 4.2 HYDROLOGY AND HYDRAULICS: A LOOK AT HIGH WATER

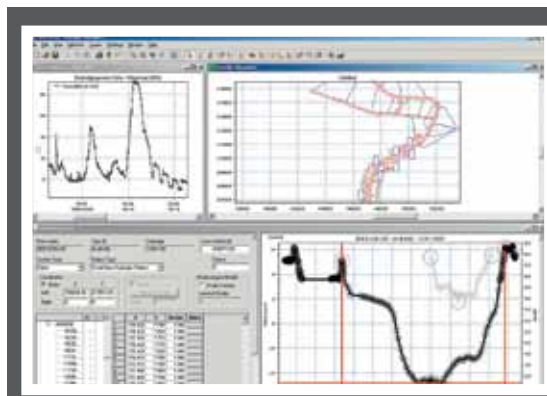
The hydrological model provides an overall description of how precipitation ends up in the watercourse via a network of ditches, streams and tributaries. Taking account of the precise dimensions, the height of the banks, the constructions present and any obstacles, the model indicates under what circumstances and at what locations the river will overflow.

The link between the weather conditions and the chance of flooding cannot be calculated simply on a straight line basis. Water falls as rain on the surface of the catchment basin, and drains into the river via a complex network of ditches, streams and side channels as well as underground. For example, to know roughly how the water level changes in the Dender as the result of a heavy shower, one must first know the flow that each individual side channel contributes to the river. The hydraulic calculations determine this relationship between precipitation and discharge for the various side channels, which will then be used to determine the water levels in the Dender itself.

To be able to produce a correct hydraulic calculation it is also important to know the prior history: has there already been a lot of rain and is the ground saturated, or does the new rain shower follow a long dry period, so that much of the rainfall can still penetrate into the soil?



Physical scale model for the lock and weir complex on the Dender



Digital models are the basis for the forecasting system





Flooding of the Dender at the “de Gavers” provincial estate, November 2010

## HIGH-QUALITY MODELS

Checking the results  
is essential

Forecasting software interface



### 4.3 THE POWER OF A MODEL

Hydraulic models are not a recent invention. In the past, detailed scale models reproducing the river bed were commonly used. In addition, rudimentary versions of computer models also existed.

However, the large-scale automation of hydraulic models is more recent. Whereas up to a few decades ago, hydraulic river models were often physical mock-ups, they are now generated by powerful computers. These computer models offer the major advantage of being relatively easy to adjust compared to scale models. If a river bed changes or if a dam is added, for example, only a few days of work are needed to adapt the model to the new situation. It is not necessary to change the entire model, merely the figures in the underlying database.

Furthermore, a hydraulic computer model also has sufficient power to process very different situations. This could include the influence a sudden downpour or storm at sea, a new dam or a sharp increase in the flow of a tributary would have on the river's water level. Finally, hydraulic and hydrological models can be linked to each other, and the model river will approximate the behaviour of the actual river even more effectively.

Due to the flexibility and speed with which results can be obtained, computer models are a powerful tool in water management. They provide a wealth of information that can offer support in making the right choices for tackling flooding at a specific location, for example. However, traditional scale models can still be useful for certain detailed studies.

#### Modelling step by step

The construction of river models takes place in different phases. Firstly, a number of measurement campaigns are carried out, for example measuring a river bed in detail every 50 metres. The longitudinal profile of the waterway, the shape of the river bed, the position of banks, dykes, dams, locks and bridges and the water use (discharges, extraction, etc.) are entered into a computer model together with a Digital Elevation Model.

In the second phase, the river model is fed with the measured hydrological data. This involves a great deal of calibration and verification: the water levels and flows calculated by the model are compared with the actual measured levels and flows. If there are any differences, the source is identified and the model is adjusted so that it approaches reality as closely as possible. The model can only be used to perform actual simulations when the calibration phase provides good results.

The effects of an intervention on water levels can then be simulated and compared with the situation without the intervention. This makes it possible to evaluate the impact of installing a backup basin, for example, or of renewing a dam or clearing the river bed.

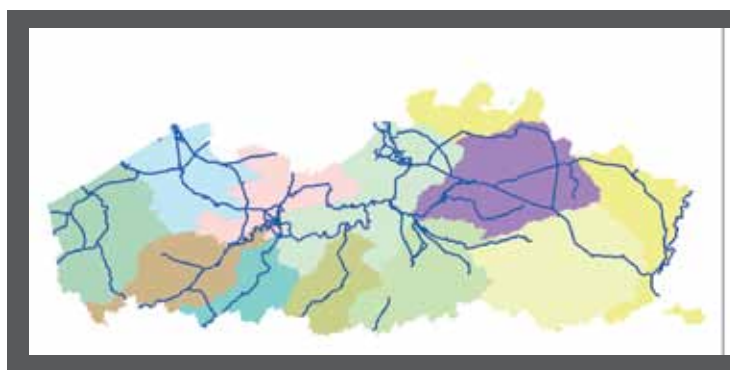
The model must then be maintained regularly, with any new locks or raised dykes being included so that the model continues to reflect the existing situation. This also applies to temporary interventions: the narrowing of a waterway due to long-term work can significantly influence the water level. The new dimensions are therefore put into the model for the period of the work.

#### 4.4 NUMERICAL MODELS FOR FLEMISH WATERWAYS

Calibrated hydraulic and hydrological models are available at HIC for all navigable waterways in Flanders. The models reflect not only the river itself, but also the height of the surrounding terrain, so that it is clear how far the water will reach if flooding occurs.



Demer floods, 1998



Navigable waterways in Flanders

# 5

## From study model to forecasting model

Recent periods of flooding have once again made the need for reliable forecasts clear. Forecasting models make it possible to provide continuous information about measured and expected water levels and flows in navigable waterways. To perform this task, the available study models of the waterways are converted into forecasting models: linking the models to the hydrological database ensures that they always calculate with the most recent measurement data. The online forecasting models are ready for use for the tidal area of the Scheldt and for the Dender, Demer, Leie, IJzer, Meuse and the system of the Zenne and the canal from Brussels to the Scheldt



IJzer floods, December 2009

### 5.1 CONTINUOUS MONITORING WHEN FLOODING IS IMMINENT

The operational forecasting models calculate the expected water levels and discharges for a 48-hour period. This method is more precise than an empirical one, but is not without its risks. Among other things, it depends on the rainfall forecasts - which themselves incorporate a degree of uncertainty.

The forecasts are performed on a completely automated basis with the online models, but it is important for an expert to always interpret the results. This is done when the daily forecasts are worked out. Even if alert or alarm levels are not reached, HIC predicts the levels and flows for the next 48 hours. In normal circumstances, forecasts are issued three times per day. In serious situations, when the alarm level is exceeded at one or more stations, HIC forecasts up to five times per day how high the water will rise on the rivers concerned, which locations will be most affected and how the situation will evolve. The forecasts are continually calibrated and adjusted using the final measurements. The models are also linked to models for the North Sea and the coast.

The forecasts and the resulting high water reports can be consulted at [www.waterstanden.be](http://www.waterstanden.be).

#### FREQUENT FORECASTS

Each model calculates  
several times per day



## 5.2 DATA: EVERY LITTLE HELPS

Recent measurements are critically important in the forecasting process. All of the available recent measurements are accessible via the central database, which is connected to the different measuring stations (managed by HIC or otherwise) which measure water levels, discharges and precipitation in Flanders and elsewhere.

In addition, forecast results are also used. Predictions for precipitation, wind, discharges and water levels are supplied by meteorological organisations and fellow waterway managers both upstream and downstream. Results from local forecasting models are also used for a number of locations. Thus the results from the model of the tidal section of the Scheldt basin are used as the downstream boundary for a number of forecasting models for zones that further upstream, such as the Dender, Demer, Leie and Upper Scheldt.

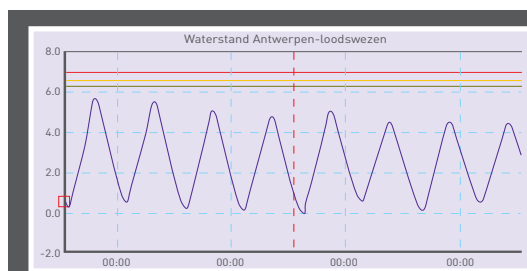
In addition to being up-to-date, data must also be accurate. The more accurate the data, the more reliable the forecast.



Wave overtopping along the quays in Antwerp



Inundation of GOG Potpolder I during storm tide



Tide forecast for Antwerp



IJzer, Reningebrug, 2006

### Precipitation forecasts

HIC does not just use its own information for forecasts. Expected precipitation data derived from a weather forecasting model is supplied by the Belgian Royal Meteorological Institute four times a day. Calculations are made for Belgium as a whole with this model for points at 7 km intervals. Each forecast covers the next 48 hours.

### 5.3 MODELS CALCULATE THE PAST, PRESENT AND FUTURE

The second step in forecasting comes after the data has been collected. Using this data, the past few days are recalculated using the real measurements as boundary conditions, in order to estimate the starting values for the new forecast. This method is called 'hindcasting'.

In a third step, expected discharges in streams and upper courses are calculated using precipitation forecasts and hydrological models.

Together with the results from other forecasting models, these flows are used as boundary conditions for the new forecast using the hydraulic model.

UNIFORM WORKING  
METHOD

HIC: a well-organised  
research group

#### 5.4 READY, STEADY, GO!

Based on precipitation and wind forecasts, the model calculates expected water levels and discharges at various locations along the river. In addition, further forecasts may be made using rainfall data that is higher and lower than the forecast figures.

The calculations include a model adjustment process that detects and minimises discrepancies between the measurements and the calculations during the hindcast period. This correction is also used to adjust the forecast results.

The forecasting models carry out calculations several times per day, going through the cycle of data collection, calculation and publication of results each time.



Closed road by the Dender downstream Geraardsbergen, November 2010



Dender measurement station at Overboelare, winter 2002-2003



# 6

## Creating an applicable and up-to-date model: not an easy feat

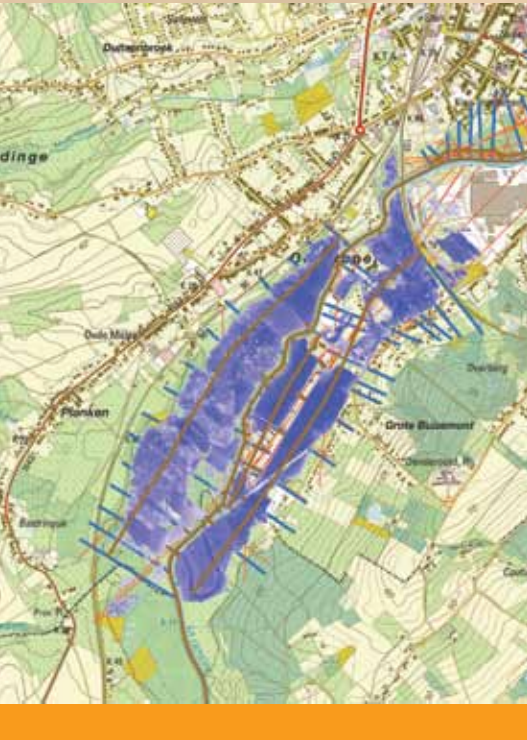
The online forecasting models are powerful aids that have raised water management to a higher level. However, these models remain computer tools, yielding results that must still be checked and interpreted by people. Continuous monitoring and adjustment are needed to keep the models usable, and HIC continues to work on improving model results.

### 6.1 INTERPRETING RESULTS

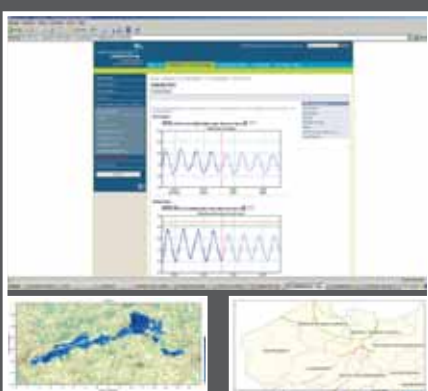
The last step in the forecasting process is certainly not the least important. The forecaster examines the results that the model has calculated via a geographical interface that provides an overview of the measurements in graphical and tabular form, clearly showing where alert and alarm levels are exceeded.

In addition to this classic model output, freeboard maps and flooding maps are also automatically produced by the forecasting system. The freeboard is the difference between the maximum water level predicted by the model and the height of the dyke. Freeboards are calculated for both the left and right banks. Thus freeboard maps indicate how large the freeboards are per river, based on the latest forecasting results. This means that locations where river banks may be overtopped can be detected quickly.

A flooding map gives a spatial understanding of the extent of the floods. The models not only generate water levels in the river itself, but include the flooding zones as well. If water is observed in the flooding zone, the flooding map will also show blue there. By taking into account the terrain elevation, the flooding depth can also be incorporated into the flooding map.



Model diagram of Overboelare airfield area with flooding map



A range of tools are available in modern water management: flooding maps, freeboard maps, real-time measurements, etc.

The combination of flooding and freeboard maps makes it possible to provide water managers with accurate information about locations in danger of flooding and the potential extent of the flood.

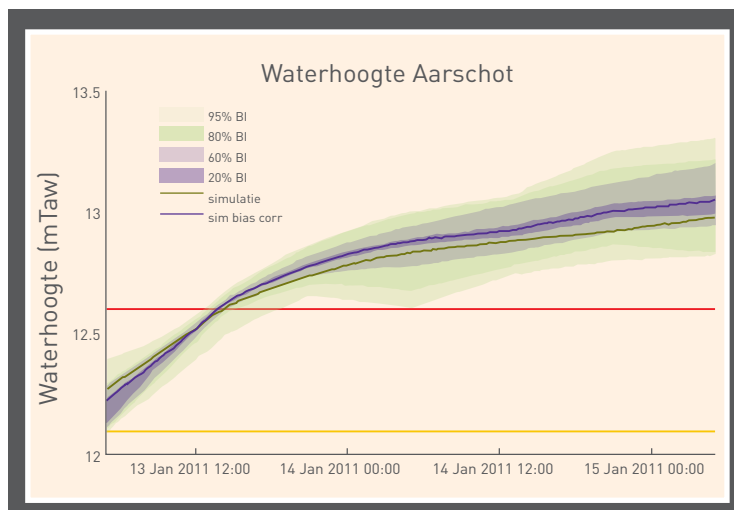
These maps are also checked by the forecaster on duty. This means the computer results are not simply accepted automatically, but are examined to see whether they are realistic and reliable. The results are also interpreted with due caution to avoid over-hasty conclusions or decisions. However, in crisis situations it is necessary to inform the affected authorities and residents in good time.

The forecaster can also have the model perform additional forecasts to simulate the effect of certain measures, such as the use of manmade structures. The impact of rainfall (more or less than predicted) can also be simulated very quickly.



### Uncertainties in model results

Every forecasting model includes a certain level of uncertainty, if only because rainfall can never be predicted 100% correctly. HIC has developed an analysis technique that makes it possible to display these uncertainties. A statistical analysis of deviations from past forecasts can be used to estimate the error in new forecast results in advance.



Uncertainty bands for model forecasting of the level of the Demer at Aarschot



Works on the Demer at Aarschot, summer 2010

## 6.2 ADJUSTING: AN ONGOING PROCESS

Using numerical models demands more than running one or more forecasts per day. For the correct operation of the forecasting system, it is very important that the models be kept current, so that they always describe the existing state of the terrain. Permanent updating and optimisation of the models are therefore necessary.

The models are continually refined and adjusted by comparing the measured levels and flows with the forecasts.

In addition, HIC is working all the time to improve the forecast results. For example, precipitation forecasts are rarely 100% correct, especially in a highly varied climate like that of Flanders. The results interpretation manager always takes account of this, and if necessary a model result can be calculated based on a little more or less rainfall.

Changes in the approach of water managers further up- or downstream are also responded to. For example, the installation of flow meters in France was useful for increasing the quality of the predicted discharge of the Leie and Upper Scheldt.

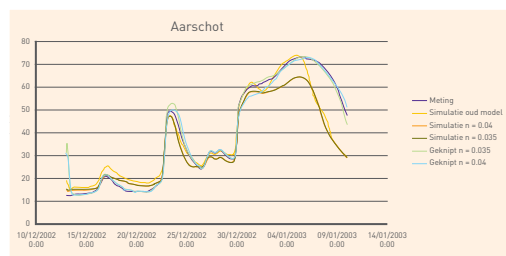
A MODEL IS  
NEVER READY

Adjusting is an  
ongoing process



## Updating the Demer model: an example

The first Demer forecast model was implemented in 2002. The model was updated in 2009, as more recent topographical measurements were available, works had been carried out in the terrain and a number of manmade structures had been adapted. The calibration of the model was adapted further to provide better model results.



Evaluation of model improvement actions



Flooding of the canal to Charleroi at Lot, November 2010

# 7



## Hoogwaterbericht

Locatie	Hoogwater		Laagwater	
	Tijdstip	m TAW	Tijdstip	m TAW
Oostende	19/01/11 12:55	4,60	19/01/11 19:25	6,40
	20/01/11 01:10	4,55	20/01/11 07:50	6,05
Zeebrugge	19/01/11 13:20	4,55	19/01/11 19:30	6,80
	20/01/11 01:30	4,45	20/01/11 07:55	6,35
Antwerpen	19/01/11 15:25	5,69	19/01/11 10:10	4,12
	20/01/11 02:50	5,58	19/01/11 22:40	4,07
Dendermonde	19/01/11 17:00	5,70	19/01/11 12:30	1,11
	20/01/11 05:25	5,59	20/01/11 00:40	1,26
Melle	19/01/11 18:35	5,73	19/01/11 14:25	2,29
	20/01/11 07:00	5,40	20/01/11 02:55	2,80

Springtijperiode: vrijdag 21/01/11 tot zondag 23/01/11

Bron: OMS, HMCZ, HIC, RWS, VMM

### 5. Volgende berichtgeving

Het volgende hoogwaterbericht zal gepubliceerd worden op 19/01/11 om 14 uur.

Leen Boeckx

HIC Permanente

Bovenstaand hoogwaterbericht is ook te raadplegen op het internet : <http://waterstanden.be>

## From theory to practice: using forecasts

Forecast results should not simply disappear into an archive box. HIC makes full use of them in its high water reporting to local actors, the other authorities involved and the public. Following a flood, the forecast results are checked and adjustments are made where necessary.

### 7.1 FROM FORECASTS TO HIGH WATER REPORTING

Tide forecasts are included in the high water report

## HIGH WATER REPORTING

Making things easier to interpret

HIC online forecasts have an important place in the continuous monitoring system developed by the centre. They make it possible to foresee imminent high water at an earlier stage, so that the warning system that both informs the affected authorities and local actors and warns the public and the emergency services can be put into action quickly. Speed and accuracy are the keywords here. How to reconcile these two remains a significant challenge for the future.

On the one hand, it is essential to have results available quickly in crisis situations. On the other hand, the data must be accurate enough to be usable. All level forecasts are performed systematically: even where no alarm levels have been reached, HIC forecasts the levels and discharges for the next 48 hours three times per day. When the alarm levels are reached, this rises to five times per day and the centre is permanently manned in order to offer support to the water managers.

### 7.2 THE MODELS AND THEIR USERS

Online forecast models are operational at HIC for all important navigable waterways in Flanders. The models of the Scheldt tidal region (Scheldt, Rupel, Durme, Dijle, Netes and Zenne), the Demer, Dender, Meuse, Leie, Upper Scheldt (with the ring canal around Ghent, the Leie deviation canal, the Ghent-Ostend canal and the Ghent-Terneuzen canal) and IJzer, the Zenne system and the canal from Brussels to the Scheldt supply forecasts several times per day.

The models and their results are mainly intended for the professional authorities involved in water management. These include the waterway managers (Flemish government, provinces and municipalities) and the emergency services, which have direct access to the model results. Currently they are processed into high water reports that are available at [www.waterstanden.be](http://www.waterstanden.be).



High water messages flag the threat of flooding

### 7.3 TAKING TO THE SKIES

When floods occur, it is important to map them as accurately as possible. A flooding map provides a wealth of information for spatial planners and can be used to further refine the models.

Extensive use is now made of flooding maps by Flemish and international policy makers. Proper video footage of floods can be an effective way of refining and/or extending such maps.

Flanders Hydraulics Research, in cooperation with AGIV (Flanders Geographical Information Systems Agency), has entered into a contract with a helicopter firm to take digital aerial photographs of floods in Flanders, within 12 hours of their occurrence. This, of course, takes place after consultation with the various water managers.

After an analysis of the different image acquisition techniques, this was found to be the most feasible option at present. The image material is subsequently processed by AGIV into a detailed flood chart, of which effective use can be made to update the scientific models, for example.



Helicopter flight IJzer 2009

### 7.4 WHAT INFORMATION AND WHERE?

Current measurements of water levels and flows are accessible for everyone on the website [www.waterstanden.be](http://www.waterstanden.be). Forecasts and the results of the forecasting models are processed in the high water reports available on the same website. Monthly low water reports are also published during the low water season.



## Publication information

### TEXT

Ministry of the Flemish Community  
Department of Mobility and Public Works  
Flanders Hydraulics Research  
Hydrological Information Centre

### RESPONSIBLE PUBLISHER

Frank Mostaert  
Division Head Flanders Hydraulics Research  
Berchemlei 115  
2140 Antwerp  
Belgium

### PUBLICATION

March 2011

### DEPOSITION NUMBER

D/2011/3241/070

More information about the models and forecasts can be obtained from:

### HIC - WL

Berchemlei 115  
2140 Antwerp  
Belgium  
T: +32 (0)3 224 60 35  
F: +32 (0)3 224 60 36  
E-mail: [hic@vlaanderen.be](mailto:hic@vlaanderen.be)





department  
**Mobility and  
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**flanders**  
**HYDRAULICS RESEARCH**  
HYDROLOGICAL  
INFORMATION CENTRE