

A toolbox with ideas to improve the effectiveness of our roads during an evacuation

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Abstract.

Exceptional circumstances need a wide scope of unusual measures. This idea has been the source of inspiration to develop the Toolbox as part of the innovation program ‘*Hoogwater? Vrije weg!*’ (High water levels? Free roads!) of the Dutch Ministry of Transport, Public Works and Water management.

In case of an imminent flooding by sea or river, what measures can we take to increase the effectiveness of our roads? More in detail: what can we do to use our roads as long and as effective as possible to evacuate people and cattle? What can we do to make the roads available for traffic as quick as possible after a flood? And how could our road constructions contribute to our water management in case of a flood situation? Inspired by these three questions measures have been collected in the application ‘Toolbox Hoogwater? Vrije weg!’ The Toolbox is available for everybody who is interested in different measures to increase the effectiveness of an evacuation.

Key words: Evacuation, water, flood, traffic, measures

Introduction

The Netherlands is largely a river delta where dikes and dunes are essential for safety. Although the safety standards for these dikes and dunes are very high, exceptional circumstances where failure could happen can't be excluded. In that case the lives of a large part of the Dutch population are in immediate danger. In this situation evacuation of inhabitants becomes an important subject.

The innovation programs WnT (Wegen naar de Toekomst, Roads to the future) and WINN (Water Innovation) of the Dutch Ministry of Transport, Public Works and Water Management started the project ‘*Hoogwater? Vrije weg!*’ (High water? Free roads!) in 2006. In April 2009 the project was completed with a final expert session in

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Utrecht. The project ‘Hoogwater? Vrije weg!’ aimed on corporation and collaboration of experts from both water management and traffic management in The Netherlands in developing knowledge on the evacuation issue.

Different activities concerning evacuation have been carried out in the project. One of them was developing a toolbox, containing all kind of measures to increase the effectiveness of an evacuation. Different ideas from the toolbox have been elaborated in more detail in the follow-up of the overall project and a traffic evacuation model has been build in which the effect of the measures can be calculated .

This paper describes the development, the content and the final result of the Toolbox ‘Hoogwater? Vrije weg!.

Evacuation: a complex process in difficult circumstances

An evacuation is a very complex process. While the water level is rising fast, many decisions have to be made in short time and a lot of radical actions has to be taken:

- Based on what and when will the decision to evacuate be made?
- How will people behave when they are evacuating?
- Which uncertainties are there and which one do we take into account?
- Which strategy will be most successful?
- Does the road capacity meet the capacity needed?
- And last but not least: what measures can be taken?

This challenge requires a lot of competences. Water management and traffic management play a crucial role in it. This has been the reason to bring together experts of both worlds in the project ‘Hoogwater? Vrije weg!’. This unique cooperation resulted in surprising new awareness for experts in both worlds.

The Toolbox: “WHAT CAN WE DO?”

The main goal of the development of the Toolbox was to define as many as possible measures to facilitate traffic management in case of an evacuation because of flooding. The participation of both water management and traffic management experts resulted in a broad variety of (sometimes out-of-the-box) solutions.

Because of the early availability of the Toolbox in the overall project the Toolbox has been successfully used as information and promotion instrument. Its interactive character makes it very suitable for demonstration and for the use in creative workshop sessions.

Different ideas and measures from the toolbox have been elaborated in the follow-up of the overall project:

- monitoring large scale evacuations,
- concepts for using highways during an evacuation,
- ways to adjust on/off ramps in case of an evacuation,

- concepts for contra flow at the rural network,
- a field experiment for contra flow at the rural network,
- incorporation of ideas from the ‘Hoogwater? Vrije weg!’ Toolbox in a GIS-based traffic model for region Haaglanden in The Netherlands.

All these goals contribute in one way or another to the most favourable and ambitious result on the long term: to create awareness, so that water management issues are incorporated into traffic management and road design practice.

Collection of ideas for the Toolbox

The Toolbox is used to collect and sort all kinds of measures that can be applied in preparation of or during an evacuation. The ideas for the Toolbox have been collected during different brainstorm sessions with experts on water and traffic management. In order to generate a wide variety of ideas three following main questions were defined:

1. What can we do to use our roads as long and as effective as possible in case of an evacuation?
2. What can we do to make the roads available for traffic as quick as possible after a flood?
3. Can we implement innovative road solutions in a way that it supports our water management in case of a flood situation?

To stimulate the creativity during the brainstorm sessions they were ‘out-of-the-box’, this means the ideas are not assessed on their feasibility.

Structure of the Toolbox

In order to get a clear overview of the content of the Toolbox, five main categories have been distinguished:

1. *Robust roads*: using the roads as long as possible even when they are flooded
2. *Flexible roads*: optimising road capacity for evacuation and assistance by traffic management solutions
3. *Information management*: optimising all available remaining road capacity by informing and recommending the public what to do
4. *Movement of people*: optimising the evacuation strategy by a combination of safety zones and remaining road capacity
5. *Compartmentalization*: using road constructions for water management purposes in order to keep the water on the desired places.

All ideas are categorized and documented in the Toolbox using standard format. This is done to present a uniform presentation to the user and to identify knowledge gaps. The Toolbox is intended as a collection of ideas, not as a complete database with well balanced information. As far as available the following information is provided for each idea:

- A brief description of the idea, including a picture

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- A description of the expected effect of the idea
- Actions needed to implement an idea
- Positive and negative impact of the idea on both water and traffic issues
- References

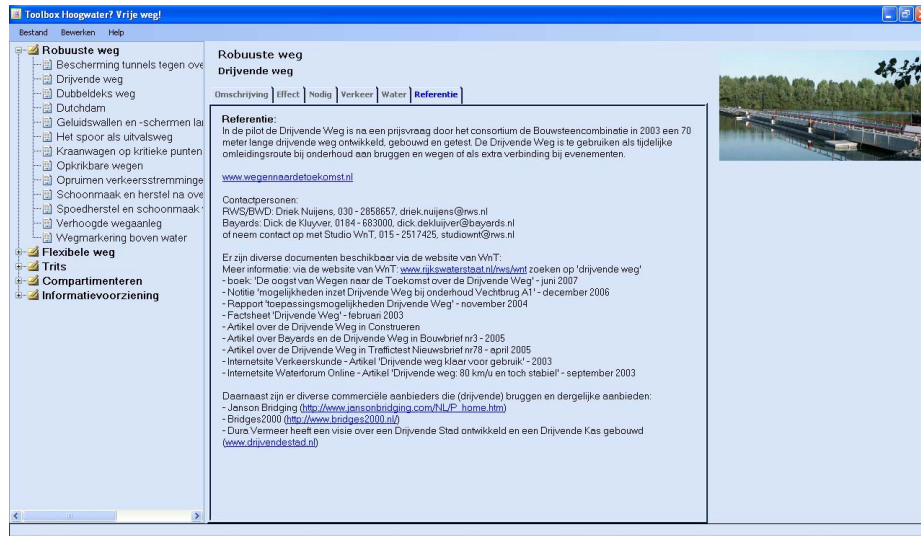


Fig. 1. Impression of the Toolbox interface.

Using the Toolbox

The Toolbox 'Hoogwater? Vrije weg!' is available as a database application with some basic user functionality:

- Ideas can be imported in the database from a text file.
- Ideas can be removed by the user
- All the available information of an idea can be send to a printer
- A special page 'PM' can be shown, this page contains extra notes or remarks concerning the idea.
- A help file is available for using the Toolbox.

Practical examples from the Toolbox

A few examples of ideas available in the Toolbox are presented. For each category a typical idea is shown. These examples give a good idea about the content and usability of the Toolbox. For this paper the format of the information presentation was adapted.

Road signs above water level (category Robust roads)

This idea is inspired on the Alps countries where sticks along roads indicate the layout of the roads under the snow. In the same way submerged roads are indicated in case of flooding.



Fig. 2. Sticks indicate the whereabouts of a road.

A road sign above the water level can be a pole or stick that indicates the position of the roadside if the road is flooded with water. With this idea roads might be available for traffic a bit longer than without the signs. Nevertheless there will be a maximum water depth for safely use of the roads for traffic. At a water depth of 10 cm, the capacity of a road has a maximum of 350 cars per hour per available lane (assuming an average speed of 7 km/h and a car distance of 20 meter).

For using the road signs above water level you need:

- Plans for the location of sticks or poles
- Sticks or poles placed along the roads before the flooding occurs
- Monitoring of the water level and the flow velocity on the flooded roads

Using flooded roads as a traffic lane is not without risk. There is an increased chance of accidents, which will decrease the capacity of the road even more. It can also be questioned how people will react to driving on flooded roads (velocity, distance, accidents etc) and whether the effort will be cost-effective if the idea is used.

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The floating road (category flexible roads)

Floating roads are temporarily or permanent roads floating on the water. These roads can be used for evacuation. The main goal is to increase the road capacity (900 vehicles per hour per lane). Bottlenecks are the access routes from the bank to the floating road.



Fig. 3. Floating road.

For using floating roads you need:

- People & equipment
- Transportation possibilities
- Communication strategies
- Suitable locations
- Plans

Not all vehicles are allowed on the floating road. The floating road was tested near Hedel (The Netherlands). The road was accessible for vehicles weighing less than 8.000 kg. Extreme wind and water conditions (waves) can reduce the availability/capacity? of the floating road. The road at the test site at Hedel matched for a wind force of 9 Bft and a water depth of the canal of max 5 meter. A floating road will increase the flow resistance in the waterway.

An example of a reference is the pilot project ‘De Nieuwe Waterweg’ from the Dutch Ministry of Transport, Public Works and Water management - WnT.

Information management using matrix signs and special vehicles (category Information management)

Dynamic information panels like matrix signs, Variable Message Signs (VMS) and mobile text cars can be used to inform the road user about evacuation routes. The information can be adapted at any moment. The aim of this idea is an improved traffic handling.

For using matrix signs you need:

- Materials (DRIP, matrix signs, mobile text cars)
- Energy supply
- Robust communication between the road traffic control centre and information panels
- Plans including possible locations, material inventory, partly predefined texts.



Fig. 4. Dynamic Route Information Panel.

For using the information systems energy supply is necessary. This means that the idea is only usable in non-flooded situations.

The 'Maatregelencatalogus Benutten' (AVV, 2005) gives more information about the use of the DRIP systems.

Shelters of the future (category Movement of people)

The shelters of the future are safe havens that can be used to temporarily shelter people, animals or goods. The locations can be inside or outside flooded areas, located in the centre of cities or even along highways. The location itself cannot be flooded and should be provided with supplies. It is possible to use potential and currently available locations, like a football stadium, and make them suitable for this goal.



Fig. 5. A football stadium is a possible shelter.

For using shelters of the future you need:

- Plans
- Suitable locations
- Accessibility of the shelters and sufficient car parking
- Risk and Crisis communication

As reference is mentioned the project ‘Verzorgingsplaats van de toekomst’ from the Dutch Ministry of Transport, Public Works and Water management - WnT. In this project the aim was to investigate the possible use of rest locations along the highways as shelter and the eventual necessary adaptations.

Sonic wall and acoustic shielding along roads used for compartmentalization (category Compartmentalization)

Sonic walls and acoustic shielding are present along many parts of roads in The Netherlands. Their function is purely noise reduction and they are not designed as hydraulic constructions. The idea is to adjust the walls and shielding so they also have a damming function. As a result the road behind the structure will be longer (hours) available for the evacuation traffic.



Fig. 6. Acoustic shielding used for compartmentalization.

For using the sonic walls and acoustic shielding you need:

- Adaptation of current constructions to give it a damming function
- Possible extension of current constructions
- Eventual connection with other dams
- Overview of locations and any ‘gaps’ in the constructions
- Information about necessary height and strength constructions
- Information about extra time (and capacity) effected by this idea

The amount of preparation necessary using this idea should be investigated, also to define whether it will be cost-effective.

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Availability of the Toolbox

The Toolbox and the use of the Toolbox is free of charge and available at the Dutch Ministry of Transport, Public Works and Water management. (studiownt@rws.nl).

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