

Author: Ir. Bas Kolen

HKV LIJN IN WATER

P.O. Box 2120

8203 AC Lelystad

The Netherlands

b.kolen@hkv.nl

T: 0320-294242

M: 06-10962684

**If things do go wrong: influence of road capacity on mass
evacuation in the event of extreme flooding in The Netherlands**

Bas Kolen¹, Stephanie Holterman¹, Kasper van Zuilekom², Klaas Friso³, Ira
Helsloot⁴

1 HKV consultants, P.O. Box 2010, 8203 AC Lelystad, The Netherlands. E-mail:
b.kolen@hkv.nl, s.holterman@hkv.nl

2 Centre for Transport Studies, University of Twente, P.O. Box 217, 7500 AE Enschede,
The Netherlands. E-mail: k.m.vanzuilekom@utwente.nl

3 Goudappel Coffeng BV, P.O. Box 161, 7400 AD Deventer, The Netherlands, E-mail:
kfriso@goudappel.nl

4 Faculty of social sciences, Free University, The Netherlands. E-mail: i.helsloot@fsw.vu.nl

Abstract. On May 30th 2008, the Dutch government informed parliament about the possibility regarding preventive evacuation of coastal and river areas in case of flooding [1]. Case studies show that it is impossible to execute a complete and total preventive evacuation of coastal areas in an unrealistic 48-hour time span preceding a possible flood caused by a storm surge [2-4]. This is mainly due to the limitations of the road capacity in proportion to the number of inhabitants in the threatened area. For river areas it seems that 72 hours is a realistic time span for completing a preventive evacuation. Initiating an evacuation requires detection, recognition and assessment (sense making) of the threat as well as decision-making by both the government and the public. The case study shows alternative strategies such as evacuating to shelters and it even supports hiding as an attractive option. These strategies require different measures (methods of approach) and different crisis management processes. The preparation of the crisis managers and decision makers should be flexible so they can compare, evaluate and decide on the different strategies of evacuation combining preventive evacuation, vertical evacuation or seeking of shelters in the threatened area.

Keywords: Evacuation, evacuation management, crisis management, flooding, decision making.

Introduction

The people in The Netherlands live in a delta, which is largely below sea level. From a historical point of view, the Netherlands has focused primarily on flood prevention, resulting in a flood defence system with the highest safety standards in the world. Floods have become very unlikely but, should they occur, the consequences in terms of casualties and damage would be very substantial. The flood protection system of The Netherlands consists of dikes, dams, storm-surge barriers and dunes. These flood defences have to meet safety standards set by law (the 1996 Flood Protection Act). Despite our safety level, absolute safety cannot be guaranteed.

In 2004 [5], the RIVM showed that The Netherlands is unprepared for a situation of extreme flooding. It also showed that the threat of flooding is one of the largest risks in the Netherlands, contributing to the overall group risk [5, 6]. The need for further preparation was addressed by the Government [7, 8]. Together with what has been learned from the experiences of Hurricane Katrina in New Orleans, the Dutch Cabinet decided to improve the preparation for floods [9].

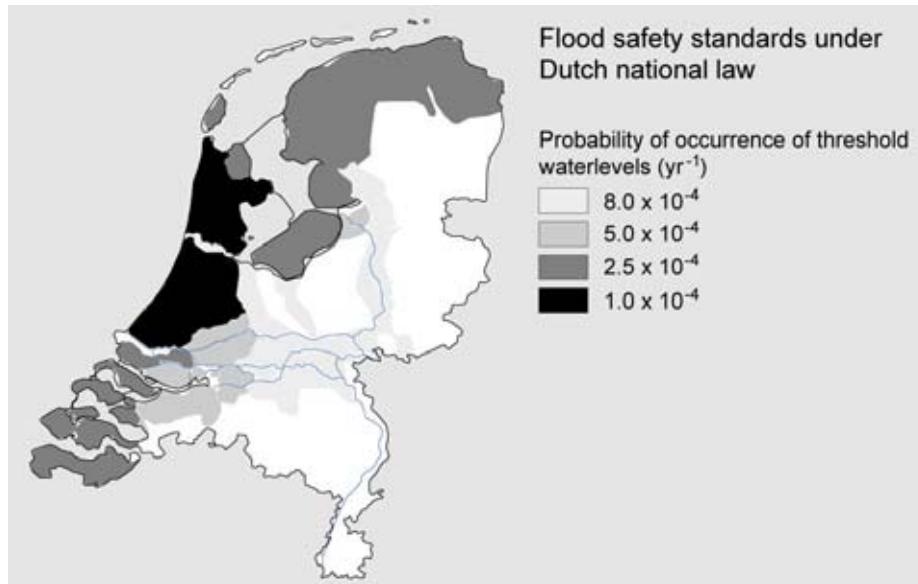


Fig. 1: Safety Standards

Evacuation is a possible measure to reduce loss of life. With evacuation, less people will be exposed to the flood if they can leave the area before a possible dike breach (preventive evacuation). If preventive evacuation is not an option people can reduce their vulnerability to the flood (and risking loss of life) by moving to a relatively safe place such as shelter or higher levels. Extra measures could be taken to reduce vulnerability and support self-reliance.

The Dutch government started a program about public safety in May 2007 [10] which focuses on the protection of the overall Dutch society with respect to internal and external risks. Part of the research project is the effects on the possible threat of flooding and the requirements to deal with these types of situations. Risk analyses for The Netherlands in 2008 [11] and 2009 [12] showed flooding to be the disaster type with the most extreme consequences (catastrophic) although the probability is low (highly unlikely) (Fig. 2).

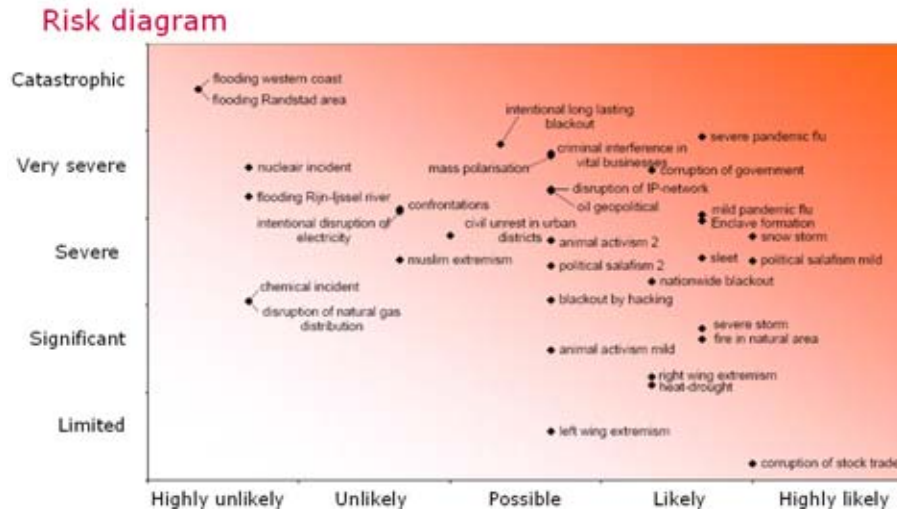


Fig. 2: Risk diagram of The Netherlands (in 2009, [12]) showing risk of different types of threats.

In the context of the analysis for available capabilities, the Dutch government did two case studies on the available capacity of the Dutch road system during different strategies for evacuation, as would be the case under threat of flooding in river and in coastal areas. The results of these studies are described and discussed in this article.

Objective of the study

The study focused on the number of people who could evacuate to a certain destination in case of flooding. Different strategies have been considered for evacuation by using the Dutch road system. The available time for evacuation of river areas is 72 hours and for coastal areas 24 hours. The stated period of 24 hours for coastal areas is equal to a period of 48 hours before dike breach as the last 24 hours will not be available for evacuation due to extreme wind speed [13]. The window of opportunity is the period preceding the breach of the dike(s) and the decision on evacuation by government and the public, after detection and realizing the possibility of imminent flooding (described as sense making by Boin et al. [14]).

The period of 48 hours for coastal areas and 72 hours for river areas is based on the system of early warning [15, 16] and the recent introduction of a national commission on flooding. [17].

This paper is the first part of a triptych. The second paper [18] is focused on the models used. In the third paper, the central theme is the lessons learned, based on experience gained during a crisis exercise in which the developed scenarios were used by crisis managers and traffic control centres [19].

Definition of (preventive) evacuation

Several definitions and interpretations of evacuation can be found in literature. For different disasters such as earthquakes [20], flooding [15, 16, 21, 22] and fire in buildings [22, 23] different interpretations are attached to the term evacuation. In this study evacuation is defined as the movement to a (relatively) safe place. The study focused on the movement in the period before the dike breach, defined as the start of the disaster. The success of an evacuation is defined as the amount of people who can reach the intended destination in time. By varying the destination of the evacuation (the location of the safe place) different types of evacuation (before a possible disaster) can be defined:

- Preventive evacuation: movement of people from an exposed area to a safe location outside this area before the disaster.
- Evacuation to a safe haven: movement to locations inside the potentially exposed area, which offer some kind of protection before the disaster.
- Vertical evacuation (or hiding): Move to higher levels before the disaster.

An evacuation strategy consists of different types of evacuation and includes all measures that have to be taken to support the evacuation. In the case study, different types of evacuation and the various forms of traffic management were used as a variable.

Method

Based on the depth of the possible flooding and the vulnerability of the people (elderly and hospitalized people are considered as a separate group) four different evacuation strategies were investigated in the study (Table 1). In Table 2 the evacuation population is presented.

The threatened area is based on the combination of worst-case scenario (worst credible floods) [13] and break down of services caused by flood in the surroundings of the flooded area. The threatened area is based on the estimated information provided at the start of the evacuation. For coastal areas it means that the entire Dutch coast is under threat. This does not mean the entire area will be flooded but that parts of this area will be inundated in the event of a dike breach. Even if given the effects of a worst-case scenario in The Netherlands, only part of the coast is flooded. Two days before a possible dike breach, both scenarios are possible. Where it concerns river areas, both of the worst-case scenarios 'Rhine and Meuse' and 'Rhine (IJssel)' are possible 72 hours before a possible dike breach. This is due to the uncertainties in predicted water levels, future stability of dikes and distribution of discharge over 'Waal', 'Lek' and 'IJssel'.

Different risk zones have been distinguished (shown in Fig. 3 (coast) and Fig. 4 (river)): a high threat area (red and yellow) and a low threat area (green). The high threat area is the area that could be flooded in one of the possible worst credible flood scenarios. The low threat area is the area which could also be flooded but the probability is much lower (breaches at other places, internal breaches) and the area in

which almost all services (electricity, gas, waste water, drinking water, telephone etc) are assumed to break down.

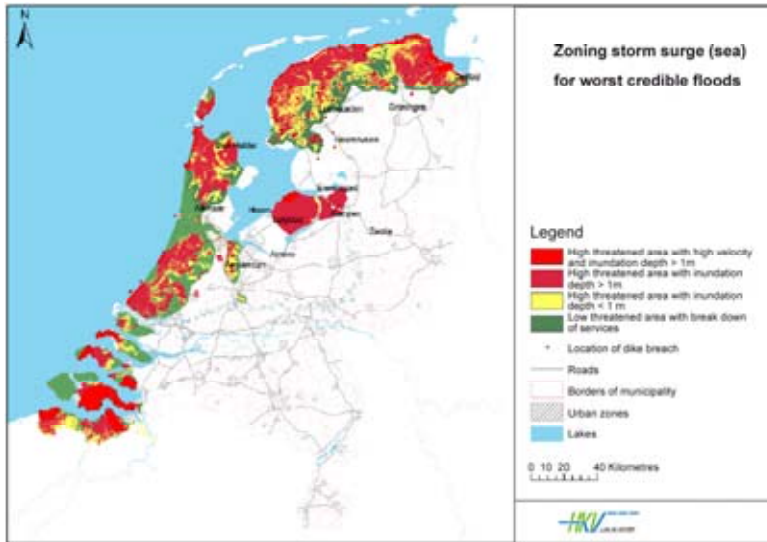


Fig. 3: Threatened area for coastal evacuation

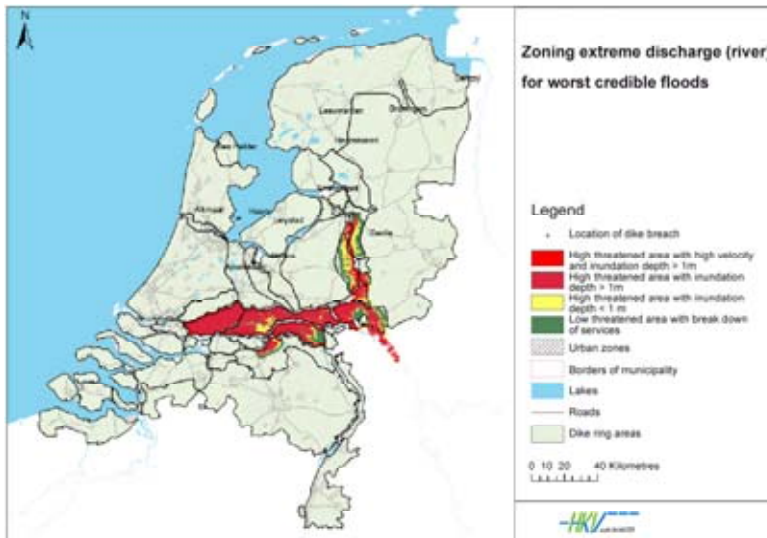


Fig. 4: Threatened area for river evacuation

Table 1: Different strategies for evacuation

	High threat area		Low threat area		
	Self-reliant	Non Self-reliant	Self-reliant	Non Self-reliant	Self-reliant
Maximum preventive evacuation	Leave	Leave	Leave	Leave	Leave
High preventive evacuation	Leave	Leave	Stay	Leave	Leave
Low preventive evacuation	Leave	Leave	Stay	Stay	Stay
Minimum preventive evacuation	Stay	Leave	Stay	Stay	Stay

Table 2: Number of people in each strategy (x 1.000 people)

	Preventive evacuation		Hiding and Shelter	
	Coast	River	Coast	River
Maximum preventive evacuation	3.900	900	900	200
High preventive evacuation	2.900	800	1.900	300
Low preventive evacuation	2.700	700	2.100	400
Minimum preventive evacuation	1.200	300	3.600	800

In the study, four different types of traffic management were used containing best and worst-case scenarios.

- Reference: this is a scenario where the inhabitants are assumed to be free in choice regarding their method of preventive evacuation. This scenario can be seen as a worst-case scenario.
- Nearest exit: in this scenario the evacuees are assumed to evacuate preventively by heading to the nearest exit, regardless of capacity and use of this exit. This scenario can also be seen as a worst-case scenario.
- Advanced traffic management: in this scenario evacuees are optimally divided over the available exit points, taking the capacity of these exit points into account. This scenario can be seen as a best-case scenario.
- National Concept Traffic Management (Fig. 5), (coastal evacuation only for strategy regarding maximum and minimum preventive evacuation), based on the method ‘flow off area’. A strategy using the entire Dutch highway system is predefined with regard to connecting origin, route and destination [2]. This form of traffic management does not only focus on the threatened area itself but also on the surrounding area. These routes are logical to the evacuees because under normal (day to day) circumstances these routes are also used to reach their destinations. Intersections between highway crossings and crossing of highways with local roads are closed; the inflow is controlled at entry points. Contra flow traffic is only introduced for emergency services using the lanes of highways normally used to enter the threatened area. The extra traffic load and extra crossings because of emergency services are not taken into account. This scenario can be seen as a best-case scenario.

These traffic management types are part of the ‘evacuation calculator’ and a more detailed description is provided by van Zuilekom et al. [22].

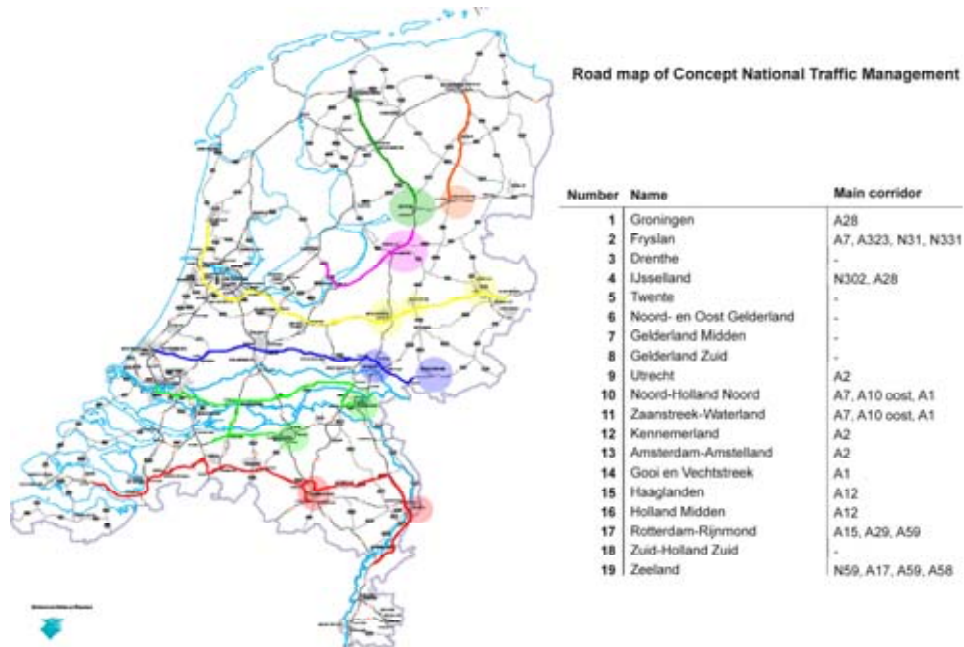


Fig. 5: National Concept Traffic Management

The High Water Information System (HIS) was used to determine the time required for evacuation by using the INWEVA network (of the Ministry of Transport, Public Works and Water Management) as the road model. Two different types of calculations were made:

- Static runs (Evacuation Calculator, [23]). This model takes into account: the number of evacuees in the area, the distribution of departure (in time) of evacuees, the road capacities and the network, the exit capacity and the effects of traffic management. The parameters of the static model were calibrated using the macroscopic model [24].
- Dynamic (and time consuming) runs for most interesting scenarios (macroscopic dynamic assignment model Madame). This model uses the (local) characteristics of the road network and takes into account the relations between travel speed, intensity, road capacity and the number of vehicles during the evacuation.

The threatened coastal area (except for National concept traffic management) is divided in assumed independent areas (Fig. 6):

- North Netherlands;
- Flevoland and surroundings;
- North and South Holland;
- Islands of Zeeland and South Holland;
- Zeeuws Vlaanderen.

of North Netherlands (and in the opposite direction) because that area is also under threat and the 'Afsluitdijk' will be closed. The river area is considered as one area. The different areas are shown in Fig. 6.

Assumptions

The following assumptions were made:

The study focused only on the movement of people. Transport of animals and transport for business continuity is considered to be a fraction of the transport for people and therefore not taken into account. The moment of dike breach is seen as the start of the disaster. In case of a storm surge it is assumed the 24 hours preceding the dike breaches are not available for evacuation because of extreme wind speed.

The probability for loss of life at each destination of the evacuation is not taken into account although this is part of the decision making process. People inside the flood zone are at higher risk than those outside this zone. Local and actual current circumstances define which locations are safer than others.

Decision making by the crisis centre and initiating the necessary preparation by the emergency services are assumed to take place at that time or in advance, using prepared emergency planning [17, 25, 26]. At the start of the evacuation people are assumed to be in their homes and roads are assumed to be empty. This means that before the decision to start an evacuation other measures, decisions and crisis communication using forecasts in accordance with national and regional emergency planning have been executed. Another assumption is the availability of sufficient resources and emergency rescue services to support the evacuation and traffic management.

The threatened area is based on the Worst Credible Flood scenarios [13]. These are worst-case scenarios that describe an upper limit. In reality, less extreme scenarios are also possible. In the study a certain time span has been assumed for preventive evacuation based on realistic early warning and decision making by crisis teams. In the coastal zone it is assumed that the start of the preventive evacuation occurs 48 hours before the possible breach. This means that only 24 hours are available for evacuation as it will be impossible to be outdoors in the final 24 hours before the breach due to extreme wind speeds. For river areas it is assumed that 72 hours are available for evacuation as the flood wave predictions on rivers have much less uncertainty.

The whole road network was assumed to be available (no blocked roads due to construction or maintenance, no traffic coming into the threatened area and no obstructions due to accidents during the evacuation).

The population to be evacuated has been divided into groups of people based on postcodes. For each postcode, about 10% of the population is estimated to be unable to evacuate without requiring assistance. They will be supported by emergency services [27, 28].

Based on an enquiry by NPS NIPO [29] the willingness to evacuate in the Netherlands is based on what has been learned from the experiences during Katrina in New Orleans [30]. It is assumed that 20% of the people in the area will not leave the area when a complete evacuation of the area is announced. This has been translated into 20% of the people not adhering to the desired strategy as announced by

the government. 80% of the population will follow the instructions of the government's evacuation strategy.

Results

The necessary evacuation time for coastal and river areas is given in Table 3. For coastal areas, the area of North and South Holland dominates the required time. Other areas need less time for evacuation. For strategy 1 and strategy 4 the time required by these coastal areas is shown in Table 4.

Table 3: Required time for transportation during several strategies of evacuation for river and coastal areas

	Reference		Nearest exit		Advanced		NCTM	
	Static	Dynamic	Static	Dynamic	Static	Dynamic	Static	Dynamic
Maximum preventive evacuation								
Coast	>72		>72		>72	71	>72	>72
River	34		>72	38	27	24	-	-
High preventive evacuation								
Coast	>72		>72		57		-	-
River	29		>72		18		-	-
Low preventive evacuation								
Coast	>72		>72		55		-	-
River	29		>72		18		-	-
Minimum preventive evacuation								
Coast	56		>72		24	22	36	34
River	20		45		18		-	-

Table 4: Time required for transportation differentiated according to coastal areas in relation to evacuation strategy and form of traffic management.

Strategy	Nearest exit (static)		Advanced (static)		Advanced (dynamic)	
	max	min	max	min	max	min
North Netherlands	>72	38	33	21	36	18
Flevoland and surroundings	62	21	26	18	18	18
North and South Holland	>72	>72	>72	24	71	22
Islands of Zealand and South Holland	55	18	23	18	27	18
Zeeuws Vlaanderen	40	18	22	18	18	18

The progress of an evacuation in the western part of The Netherlands in the event of maximum preventive evacuation is shown as dynamic management in Fig. 7. The same situation using the National Concept Traffic Management is shown in Fig. 8. Detailed analysis shows some clear bottlenecks in the road network and the strategies inside the evacuation zone (or exposed area) but they also occur outside this zone with regard to the outflow.

There are bottlenecks inside the exposed zone. Fig. 7 shows the results of 'advanced' traffic management during the first day of the evacuation, where the A 13 motorway is used. After one day most traffic is gone. More to the south, a regional

road running almost parallel the river 'Nieuwe Waterweg' becomes overloaded one day after the start of the evacuation. People from The Hague and Westland are directed to use this road instead of other roads.

Bottlenecks in the road system outside the threatened area can have a negative impact on the success of preventive evacuation. A major bottleneck is the A12 (blue circle in Fig. 8) near Gouda where the A12 (from The Hague) and the A20 (from Rotterdam) link up with the A12 reducing the number of lanes from 4 to 3. The model shows the effect on the traffic already in the exposed area.

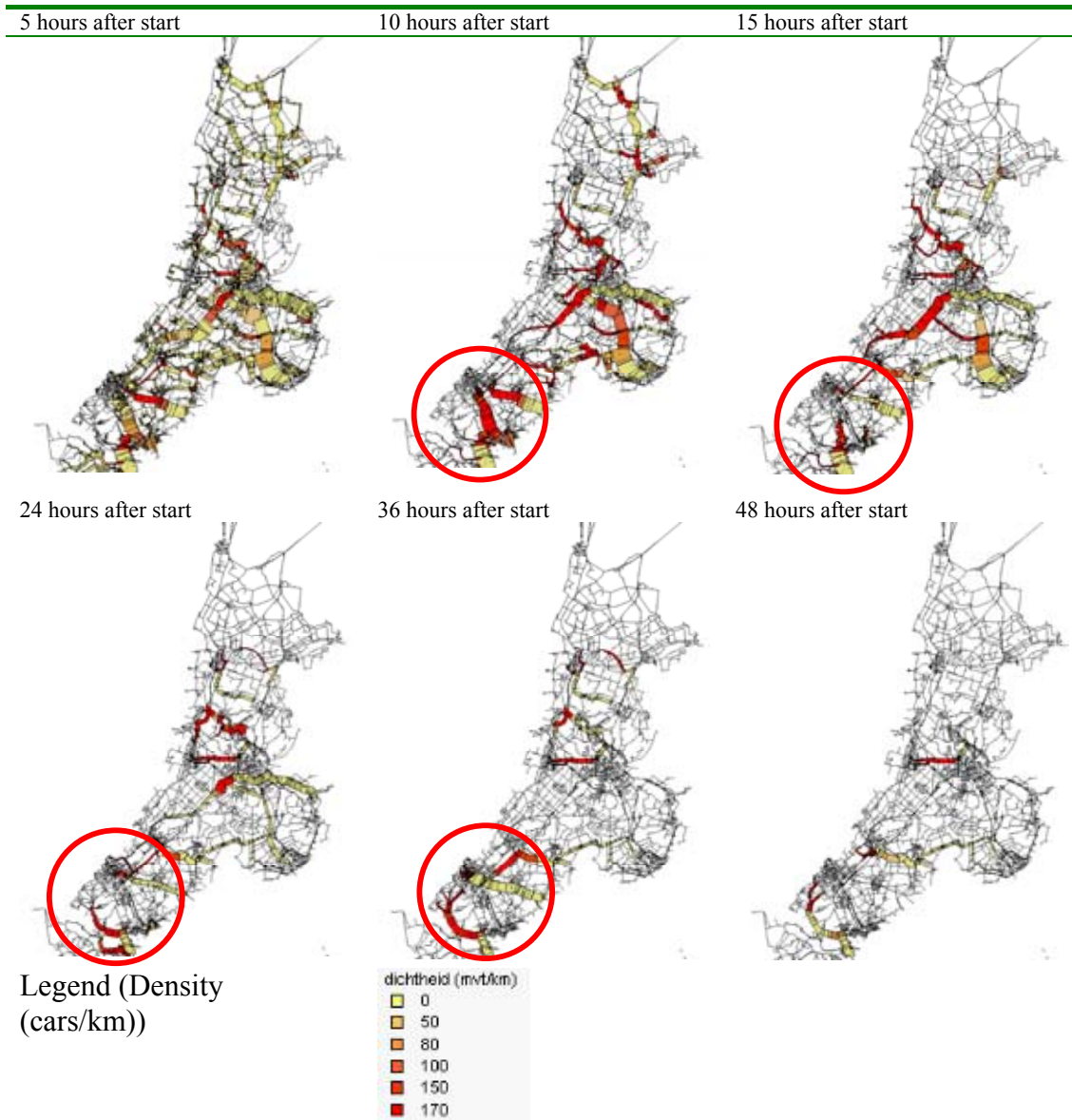


Fig. 7: Progress of maximum preventive evacuation in Western Holland with advanced form of traffic management.

5 hours after start



10 hours after start



15 hours after start



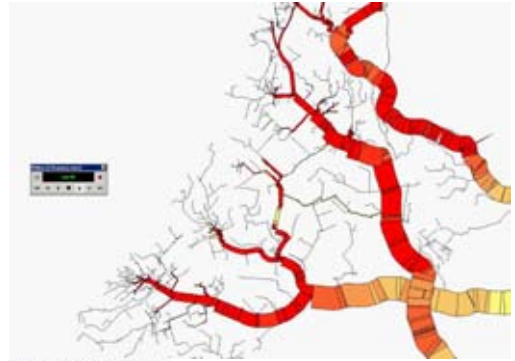
24 hours after start



36 hours after start



48 hours after start



Legend



Density (cars/km)

Fig. 8: Progress of maximum preventive evacuation in Western Holland with National Concept Traffic Management, showing a bottleneck on A12-A20 outside the threatened area near Gouda evacuation.

Discussion

Limited road capacity

In river areas the road capacity is not a limiting factor in a preventive evacuation in a 72 hour period. For coastal areas, a total preventive evacuation is impossible within 24 hours. A large variety of regional differences can be seen, smaller areas might be able to evacuate preventively in 24 hours. The area of North and South Holland has the most significant problem due to the number of evacuees and the limited road structure. A total preventive evacuation will take more than 72 hours considering the outflow from the area. A strategy focussed on a minimum preventive evacuation (about 30% of the inhabitants) will still take at least 24 hours under storm surge conditions. Considering the assumptions, this can be defined as a best case scenario. The evacuation time required increases dramatically (threefold increase) without advanced traffic management.

In local, less-populated areas, preventive evacuation is a more realistic option. For example, an evacuation of Zeeland would require approximately 24 hours with advanced traffic management (35 hours without).

Scenarios: Worst-case, smaller or both?

The case study focussed on the concept of worst credible flood scenarios [13]. These scenarios are defined as worst-case by ten Brinke et al [31]. The need for worst cases is addressed by Clark [32], worst cases are used to find out what could happen under very extreme conditions. In reality it is more likely for other, less extreme scenarios to occur. In the event of flood, the exposed areas will probably be smaller. Evacuation could still be a problem. Jonkman [16] describes the time that would be required for a preventive evacuation of a smaller coastal area (around The Hague) in the event of flooding. Jonkman assumed a deterministic flood scenario, which means that it is assumed that the size of the flood is (assumed to be) known at the start of the evacuation (hours or days before the dike breach). Even a small area such as this addresses the issue of the impossibility of a preventive evacuation.

In reality, decision making preceding a dike breach has to take place while the size of the potential flood, location, number and location of dike breaches are unknown quantities. The time that is still available is also an unknown factor as detection of the possible extreme water levels by experts and the assessment [14] by crisis managers and decision makers is required in order to start the decision making process. This means that in reality, the assumed available time and size of the threatened area could be larger or smaller than assumed in the case study (Fig. 9).

Scenarios with almost no early warning time are conceivable, also in river areas (for example because of the piping mechanism [33]).

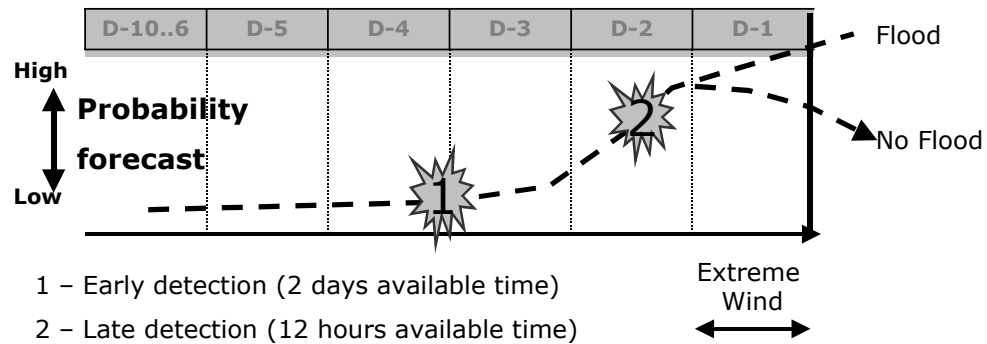


Fig. 9: Difference between early and late detection and assessment (sense making)

Outlines for several different evacuation strategies should be prepared.

Different evacuation strategies (Fig. 10) should be prepared on all levels of governmental organizations. This could result in an organization with some degree of resilience and flexibility. The organization should consider large disasters (worst-case) and smaller floods as well as different periods of available time. Other elements to be considered are human behaviour, cooperation between governmental organizations and emergency services. In cases of imminent threat, governmental decision makers have to take several factors into account. The possible deterioration of strategy and the available infrastructure owing to bottlenecks and traffic jams caused by spontaneous evacuation as it might be impossible, or highly ineffective, to change to a different strategy at a later stage. Transportation and rescue services (if available) are also going to require more time. For an effective response, possible future effects must be anticipated. Assessments have to be made on whether future options will still be available at a later stage and, if this seems unlikely, to take immediate or timely action. Most of the important decisions have to be made before the start of each strategy. This means most important decisions are made based on (very) uncertain information.

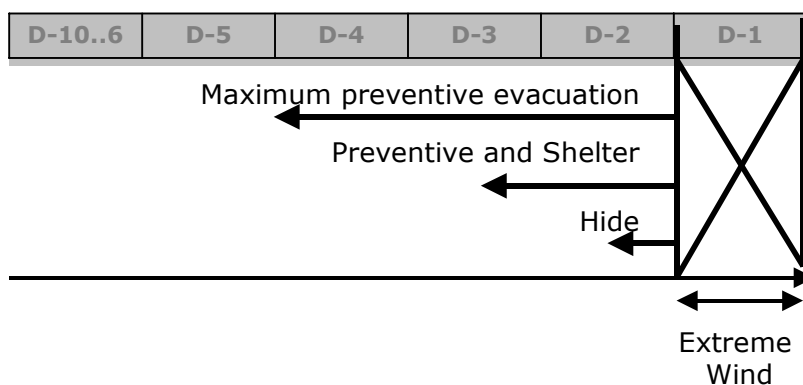


Fig. 10: Time required for different evacuation strategies (in succession from D-1)

Decision making is to anticipate the future

When government decides to announce a threat and communicates that evacuation is a realistic course of action, it is clear that the population in a threatened area will not act solely on information from the government. Literature on self-reliance [34] shows that people act differently on information, based on their perception and belongings. When viewed from a different (or overall) perspective, the behaviour of each individual might not seem logical or it could even look like panic. However, from the perspective of the person concerned it is the most realistic course of action. Research [34, 35] shows most people make rational decisions using the available information from the government but also consult other sources of information.

In this article, 20% of the people are assumed not to act in conformance with the government strategy (for example maximum preventive evacuation) and therefore, they do not use road capacity. The other 80% follow instructions and act according to expectation. People are assumed to be self-reliant to a certain degree because they use their own transportation to move to safe areas. Given the definition of self-reliance, it will be logical to assume that people will be choosing different and additional routes.

Traffic management should consider the route of origin and destination, which means national traffic management for the Dutch situation. Local measures can reduce local bottlenecks, which could make a substantial difference for one strategy. The desired form of traffic management has to be implemented before start of the evacuation. Time for implementation and communication to the public is needed. Decisions should be made up to the national level because national traffic management affects the entire country, economically and socially. Public behaviour is a constraint in traffic management.

Optimizing the use of the road capacity does not only depend on the available roads and the people who have to be evacuated, it also depends on the behaviour of people. Unforeseen events such as accidents (which are known to happen, but can not be planned), the activities in crises centres and the communication by government have an impact. It also depends on the available time between the possible breach of a flood defence and the moment the possible threat is recognized.

Emergency planning for a preventive evacuation does not mean preparation for evacuation. Emergency planning should also consider other types of evacuation and what the requirements would be with limited time or a shortage of people and equipment.

Conclusion

The road capacity in The Netherlands is insufficient for a total large-scale preventive evacuation in a period of 24 hours for coastal areas. For river areas a preventive evacuation is possible in 72 hours. Traffic management reduces the time required for evacuation. The provinces of North and South Holland, the economic hub and the most valuable part of the Netherlands, are coastal areas and need the most time for preventive evacuation. Other areas need less time to evacuate but, under most circumstances, more than a day. The case study shows at least 20% of the people are still in the area after 24 hours.

Warning at an earlier stage increases the possibility for preventive evacuation. For the western part of the Netherlands (economically most valuable) 72 hours is needed in a best-case scenario which means the warning period has to be increased dramatically. Combined with the assumptions - 1) public behaviour and 2) the cooperation between the parties involved in the decision making process and during the evacuation such as (semi) governmental organizations, emergency services (and the public) - it seems unrealistic that a preventive evacuation in all coastal areas will be possible in the available time.

Besides this, the high Dutch safety standards, which have reduced the risk enormously, have resulted in a lack of experience in such extreme and potentially dangerous situations. This will be addressed in more detail in the third part of this triptych [19].

Preparation, more efficient use of available infrastructure (think of adaptive measures as reverse lane use or flexible exit and entry points), more efficient decision making and higher risk perception can improve the success of evacuation. These issues will be constraints during a crisis. More research is needed about the relation between all those elements and the contribution to prevent the risk of loss of life.

Disaster management planning for flooding in the Netherlands has to be based on scenarios of different scales. In view of the complex and chaotic nature of a flood and evacuation, the relation between all the stakeholders involved should be the starting point for preparation and response.

It is realistic to assume that a complete preventive evacuation of coastal areas is sometimes impossible after identification of a possible threat. This requires alternative strategies such as vertical evacuation, individual shelters and maximising the self-reliance of the population. Advance preparation of outlines and an overall framework for these scenarios could make it easier for national policymakers to co-ordinate and reduce (possible) casualties and damage.

The decision making process surrounding these scenarios is influenced by short reaction times, possible life and death situations and a huge economic impact. Decision making for evacuation before the moment of a dike breach means coping with uncertainties while anticipating future developments. Decisions must be based upon risk analyses and represent the uncertainties, which should be continuously updated using current information and possible future developments.

To implement national traffic management for evacuation, especially when a complete preventive evacuation is impossible because the available time is limited, the highest decision maker involved (in The Netherlands this is on national level in the person of the Minister of Interior) has to be put in charge immediately. Because of the possible impact, a top-down approach is needed immediately after detection of the possible threat. He or she will be responsible for starting up the entire crisis organisation, operational planning, and communication and, after considering the alternatives, the final decision making. In the Dutch situation it will be The Minister of Interior who will have to initiate the process of assessing and informing all stakeholders involved (national and regional crisis organization, public and private companies) about the situation and what the expectations are. Even if after assessment, no actions are initiated because the probability is low and the impacts of possible decisions are enormous, all stakeholders have to be informed. The benefit is that all stakeholders have a same point of departure on the overall approach on which

they can agree or disagree. A more classic bottom-up approach results in each organization being responsible for their own assessment (and sense making) of the situation which could lead to a more time consuming decision making process or to contradictory decisions between several regions and organizations. This bottom-up approach could be counterproductive in effective use of the road network and in strategies for evacuation. In the final decision making process, it is likely the decision process could be faster if a decision maker on the overall level is involved. Other parties are responsible for providing the alternatives and showing the consequences of decisions and, in the end, accepting the decisions made. Where it concerns mass evacuation (before the start of a disaster) all options will have an enormous impact on society but mass evacuation could also reduce loss of life in the event of a flood.

Acknowledgements

Ton van der Putten and Marieke Oosthoek (Ministry of the Interior and Kingdom relations) and Kees van Ruiten (Deltares) are gratefully acknowledged for their work on capabilities analyses and simulation of evacuation in case of flooding. We would also like to thank Erik Wegh for his contribution and work for the National Concept Traffic Management at the National Traffic Centre.

References

1. (BZK), Ministry of the Interior and Kingdom relations: Kamerstukken II, 2007-2008, 30821 nr. 6. The Hague (2008)
2. Holterman, S., Leenders, J., Kolen B., Friso, K., Kwant, A., van Zuilekom, K.M.: If things do go wrong: Influence of nation concept of traffic management on possibility for different strategies for evacuation on a national scale in case of potential flooding (in Dutch). HKV lijn in water, Goudappel Coffeng, Universiteit Twente. Lelystad (2009)
3. Ministry of the Interior and Kingdom Relations, Ministry of Transport Public Works and Water Management: Capacity analysis for the task large-scale evacuation. Report National Security (in Dutch). The Hague (2008)
4. Kolen B., Holterman, S., van Zuilekom, K.M., Friso, K.: If things do go wrong: Influence of road capacity on possibility for different strategies for evacuation on a national scale in case of potential flooding (in Dutch). HKV Lijn in water, University of Twente and Goudappel Coffeng. Lelystad (2008)
5. RIVM: Dutch dikes and risk hikes. A thematic policy evaluation of risks of flooding in the Netherlands. Bilthoven (2004)
6. ten Brinke, W.B.M., Bannink, B.A., Ligtoet, W.: The evaluation of flood risk policy in The Netherlands. Journal on Watermanagement. Volume 151 Number 4: p. 181-188 (2008)
7. Ministry of the Interior and Kingdom Relations, Ministry of Transport, Public Works and Water Management: Strategies for flood disaster control along the rivers Rhine and Meuse (in Dutch). The Hague (2005)
8. Ministry of the Interior and Kingdom Relations, Ministry of Transport, Public Works and Water Management: Cabinet standpoint disaster management floods (in Dutch). The Hague (2006)
9. Remkes, J.: Decision implementing 'Taskforce Management Flooding' (in Dutch). Staatscourant. nr 241 (2006)
10. (PNV), Program National Security: National Security, Strategy. (in Dutch). Ministry of the interior and kingdom relations. The Hague (2007)

11. (BZK), Ministry of the Interior and Kingdom relations: National Security, National risk assessment 2008 (in Dutch). Ministry of the Interior and Kingdom relations. Den Haag (2008)
12. (BZK), Ministry of the Interior and Kingdom relations: National Security, National risk assessment 2009 (in Dutch). Ministry of the Interior and Kingdom relations. The Hague (2009)
13. Kolen, B., Wouters, C.A.H.: If things do go wrong: flood scenarios for contingency plans (in Dutch). HKV lijn in water. Lelystad (2007)
14. Boin, A., 't Hart, P., Stern, E., Sundelius, B.: The politics of crisis management. Public leadership under pressure. Cambridge, UK. (2005)
15. van Noortwijk, J., Barendregt, A.: Available and necessary time for evacuation in case of possible flooding (in Dutch). HKV lijn in water. Lelystad (2004)
16. Jonkman, S.N.: Loss of life estimation in Flood' risk assessment. Theory and applications. PhD Thesis. Delft University of Technology. Delft University. Delft (2007)
17. Ministry of Transport, Public Works and Water Management: Emergency plan "Extreme water level and storm surge". Guideline for a national approach. (in Dutch). The Hague (2008)
18. Friso, K., van Zuilekom, K.M., Kolen, B., Holterman, S.: If things do go wrong: lessons learned concerning traffic management during mass evacuation in case of possible extreme flooding in The Netherlands., Conference: ICEM09, Delft (2009)
19. Kolen, B., Wegh, E., den Hollander, J., van der Leun, W., Holterman, S., van Zuilekom, K.M., Friso, K., Helsloot, I.: If things do go wrong: crisis management vs national traffic management in case of possible extreme flooding in The Netherlands., Conference: ICEM09, Delft (2009)
20. Chien, S., Chen, L., Chang, S. Cui, G., Chu, C.: Development of an after earthquake disaster shelter evaluation model. Journal of the Chinese institute of engineers. . 25 5: p. 2 (2002)
21. Wolshon, B.: Evacuation Planning and Engineering for Hurricane Katrina. The evacuation of New Orleans had some unprecedented successes and glaring failures. The bridge national academy of engineering. Vol. 36 No. 1: p. 27-34 (2006)
22. van Zuilekom, K.M., van Maarseveen, M.F.A.M., van der Doef, M.R.: A Decision Support System for preventive evacuation of people., in Geo-information for disaster management, P. Zlatanova Van Oosterom, S. Fendel, E. M. , Editor., Springer Berlin Heidelberg. p. 229-253. (2005)
23. Barendregt, A., van Noortwijk, J.M., van Maarseveen, M.F.A.M., Tutert, S.I.A., Zuidgeest, M.H.P., van Zuilekom, K.M.: Evacuation in case of possible flood (in Dutch). HKV lijn in water and University of Twente. (2002)
24. Meinen, M.: Preventive evacuation of a dike in case of possible flood - proposal to improve insights for preventive evacuation by "Evacuation Calculator" using macroscopic dynamic assignment model MADAM. (In Dutch). University of Twente. Enschede (2006)
25. (BZK), Ministry of the Interior and Kingdom Relations: National crisis plan Extreme Water Levels and Flooding. (in Dutch). The Hague (2007)
26. Kolen, B., Leenders, J.K., Schaap, J., Dijk, D.M.: Roles of the national governmental organizations in case of mass evacuation in The Netherlands. Guidelines for evacuation and an emergency plan (coordination and decision making) for the national level (in Dutch). HKV lijn in water, Oranjewoud Save. Lelystad (2007)
27. (CBS), Statistical data Statline: <http://statline.cbs.nl> (2008)
28. (RIVM), National Care Atlas (Nationale zorgatlas): http://www.rivm.nl/vtv/object_document/o4235n21143.html (2008)
29. NIPO: Risk perception of flooding related to willingness to evacuate (in Dutch). Amsterdam (2006)

- \
30. Kok, M., Vermeij-Braak, E., Kanning, W., Kolen, B., Thonus, B., Adams-Tonk, A.: Two years after Katrina (in Dutch). Lelystad (2007)
 31. ten Brinke, W.B.M., Kolen, B., Dollee, A., van Waveren, H., Wouters, C.A.H.: Contingency planning for large-scale floods in the Netherlands (concept). *Journal of Contingencies and Crisis Management*. (2009)
 32. Clarke, L.: Worst cases. Terror and catastrophe in the popular imagination. (2006)
 33. Ministry of Transport, Public Works and Water Management: Flood Risks and Safety in the Netherlands (Floris). The Hague (2005)
 34. Helsloot, I., Ruitenbergh, A.: Citizen response to disaster; a review of literature and some applications. *Journal on Contingency and Crisis Management*. Volume 12 Number 3: p. 98-111 (2004)
 35. III, Henry W. Fischer: Terrorism and 11 September 2001: does the “behavioral response to disaster” model fit? *Disaster Prevention and Management*. 11: p. 123-127 (2002)