Filling in the Blanks: Constructing Effective Flood Warning Messages Using the Flood Warning Communicator (FWC)

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ABSTRACT

This paper reports the progress that is being made in developing a software tool (the Flood Warning Communicator, FWC) that helps communication professionals constructing effective flood-warning messages. The program provides authorities with a warning message that contains open spaces where event specific information can be inserted. The program uses a database containing (parts of) phrases. Based on the specific situation, a communication professional receives the most suitable standard phrase by clicking on information buttons in a user interface. Together, the phrases form the warning message that sometimes requires minor adjustments such that it suits the specific circumstances. FWC is a well working prototype that allows constructing messages for web sites and short text messages (sms). Research is needed to test and validate these warning messages. In addition, cooperation with public authorities is necessary to make the program suitable for local circumstances (e.g., safety regions and municipalities).

Keywords

Flood, warning communication, risk perception, protective action, citizens.

INTRODUCTION

The human response to warnings for natural hazards is affected by many factors. Such factors include, for instance, citizens' reception of a warning, the psychological processing of a warning and the subsequent interpretation of the message. Reception, attention, and comprehension are also influenced by the absence or presence of environmental cues (e.g., rising of water levels in case of an approaching flood) and cues from the social context (e.g., media reporting, communication with family, friends, neighbors). Finally, the decisions that people make depend on their personal characteristics, such as their existing beliefs about the threat (i.e., risk perceptions), their prior experiences, their assessment of protective actions (e.g., the efficacy of a behavioral response such as evacuation for protecting people and property), and the situational constraints (e.g., insufficient time or knowledge to implement protective actions) (Lindell and Perry 2004).

To increase the likelihood that citizens heed warnings, authorities can use public education campaigns in order to stimulate risk awareness and explain warning procedures. In addition to stimulating preparedness among citizens, authorities can also improve the quality of the warning process. Preparedness of citizens and optimal, timely warnings can be crucial, especially when warning times are short and when people have difficulties to recognize environmental cues.

Authorities can optimize their warning communication by developing effective warning messages. Although the precise formulation of warning messages depends on the actual circumstances, developing (parts of) messages beforehand prevents them from lacking elements and content. A predesigned message structure improves the consistency between messages and reduces the required time for designing and approving a warning message. This paper reports the results of an ongoing research and innovation project that aims at developing a warning communication working prototype for assisting communication professionals in drafting flood-warning messages in the Netherlands. The purpose of this paper is to present and discuss this tool, the Flood Warning Communicator (FWC).

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THE CONTEXT: FLOOD RISK MANAGEMENT IN THE NETHERLANDS

The Netherlands is situated on the deltas of the River Rhine, Meuse, and Scheldt. For centuries the primary aim of water management has been to protect this low-lying, waterlogged country against flooding by building and maintaining sizeable defences. After the last major flood in 1953 the Dutch build the Delta Works, a comprehensive plan detailing the construction of several large dams and barriers and the reinforcement of many dikes and dunes. In addition, standards for flood protection were expressed in exceeding frequencies of high water levels (Ten Brinke and Bannink 2004). The protected areas are referred to as 'dike rings'. The primary flood defences (e.g., dikes, dunes, barriers) are the flood defences along the major rivers and around the lake area in the heart of the country, as well as the sea defences along the Dutch coast.

The National Water Plan (2009-2015) describes the current priorities and choices in flood risk management. For the first time there is explicit attention for mitigation of flood consequences through spatial planning and flood crisis management including citizen participation. Herein prevention, spatial planning, and crisis management are seen as 'layers'. The first layer, the prevention of floods, is and remains the fundament of Dutch flood risk management. The second and third layer (spatial planning and crisis management) will help to mitigate the potential flood consequences. Specifically, improving flood-warning procedures belongs to the third layer of improving flood crisis management.

THEORETICAL BACKGROUND: REQUIREMENTS FOR CONSTRUCTING WARNING MESSAGES

Developing the FWC was inspired partly by recognising the crisis communication professionals' needs for stand-by effective flood-warning messages and partly by the literature that deals with human response to warnings. Two theories that deal with human response to warnings for natural hazards are Mileti and Sorensen's (1990) warning response model and Lindell and Perry's Protective Action Decision Model (PADM). In particular, the PADM was first developed to explain people's protective action decisions in response to imminent disasters (Lindell and Perry 1992, 2004), but has recently been extended to account for people's long-term hazard adjustments (Lindell and Perry 2000). Terpstra (2010) applied the PADM to study Dutch citizens decisions in flood preparedness. The PADM therefore served as an important theoretical background for developing the FWC. Specifically, it models citizens' protective action decisions as a stepwise process. These steps are reflected in five successive questions including 1) "Is there a real threat that I need to pay attention to", 2) "Do I need to take protective action", 3) "What can be done to achieve protection", 4) "What is the best method of protection", and 5) "Does protective action need to be taken now?" In addition, warning messages should be specific and as brief as possible, so that citizens will not to have to go through irrelevant information that increases the likelihood of distraction. Lindell and Perry (2004) therefore recommend that warning messages answer the following questions (p.108-109):

1. Who is issuing the warning?
2. What type of event is threatening?
3. Who is being threatened?
4. When is the anticipated impact expected to occur at the warning recipients location?
5. How intense is the event expected to be at the warning recipients location?
6. How probable is it that the event will strike the warning recipients location?
7. What specific protective actions should be taken?
8. Are there high-risk groups that require special actions?

Using a predefined message format ensures that all necessary information is included in the warning message, yet helps to keep the message as brief as possible. This is precisely what the FWC aims for. It provides authorities responsible for issuing flood warnings with a warning message that contains open spaces where event specific information can be inserted.

FILLING IN THE BLANKS: THE FLOOD WARNING COMMUNICATOR

Figure 2 shows the interface of the FWC. The interface consists of two panes. The left-hand pane consists of eight blocks where the communication professional needs to select or insert information. The blocks are labelled as follows—1) threatened area, 2) threat intensity, 3) current weather, 4) weather forecast, 5) flood consequences, 6) evacuation strategy, and 7) information services. The eighth block is not related to the warning content but to the communication strategy, and therefore has no number. That is, it allows selecting the warning channel and the style of the message. The right-hand pane initially only contains bold headings corresponding to the information blocks titles. Together these headings form the blank message format. By selecting buttons and inserting information in the left-hand pane, the right-hand pane presents the selected standard sentences from a database that together form the flood-warning message.

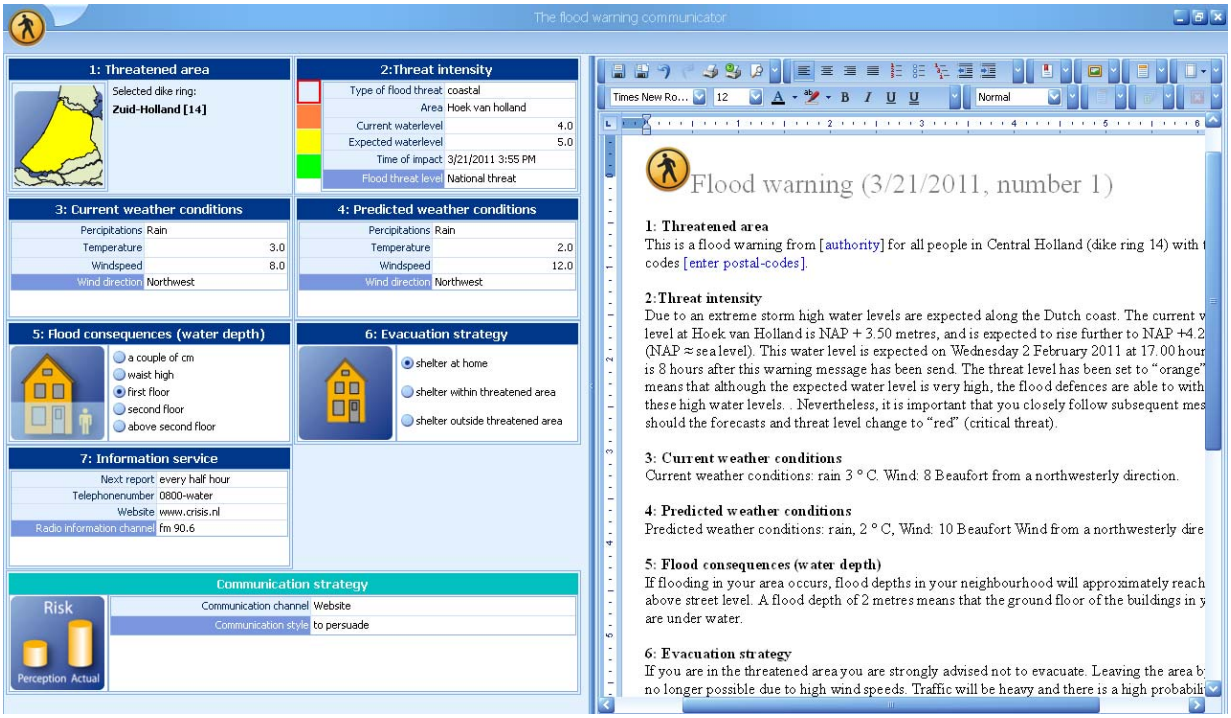

Figure 2. User interface of the Flood Warning Communicator

Block 1: Threatened area

Within the first block the communication expert selects the threatened area from a GIS-based map. . The standard sentences that are subsequently generated in the right pane contain three types of information: 1) Who is issuing the warning? 2) What type of event is threatening? 3) Who is being threatened?:

> ***Threatened area***
> *This is a flood warning from [authority] for all people in Central Holland (dike ring 14) with the postal codes [enter postal-codes].*

Thus, the first block aims to alert citizens to an increased probability of flooding, and to provide them with a clear demarcation of the threatened area by providing them with detailed geographical information. The brackets allow the local communication professional to insert the warning source and the threatened postal codes.

Block 2: Threat intensity

The second block aims at specifying the threat. That is, in this block the communication professional explains what causes the threat, the current and expected water level, as well as the moment that water level is expected to occur. Threat intensity is also indicated by a colour-coded threat level system, ranging from 'green' (normal situation) via yellow/orange (regional/national threat) to 'red' (critical threat). The coding system is identical to the system that is used by the National Committee for Flood Threats in the. Thus, the second information block answers the questions 1) "When is the anticipated impact expected to occur at the warning recipients location?" 2) "How intense is the event expected to be at the warning recipients location?" and 3) "How probable is it that the event will strike the warning recipients location?" For example:

> ***Threat intensity***
> *Due to an extreme storm high water levels are expected along the Dutch coast. The current water level at Hoek van Holland is NAP + 3.50 metres, and is expected to rise further to NAP +4.20 metres (NAP ≈ sea level). This water level is expected on Wednesday 2 February 2011 at 17.00 hours, which is 8 hours after this warning message has been send. The threat level has been set to "orange". This means that although the expected water level is very high, the flood defences are able to withstand these high water levels. . Nevertheless, it is important that you closely follow subsequent messages should the forecasts and threat level change to "red" (critical threat).*

Block 3 and 4: Current and predicted weather

Providing weather information can be important for two reasons. First, observing the weather provides citizens with environmental cues that help them identifying the threat, while environmental cues such as high water levels may not have arrived at the time when the warning is issued. Second, weather forecasts also provide citizens with an image of the circumstances under which they are required to take protective action.

Current weather conditions
Current weather conditions: rain 3 ° C. Wind: 8 Beaufort from a northwesterly direction.
Predicted weather conditions
Predicted weather conditions: rain, 2 ° C, Wind: 10 Beaufort Wind from a northwesterly direction.

Block 5: Flood consequences

Block 5 conveys the expected consequences should the flood defences fail. In particular, the communication professional can use this block to explain the expected flood water depths. The expected flood depth should help people to personalize the threat. This is done by indicating the flood depth relative to the height of people's and homes.

Flood consequences (water depths)
If flooding in your area occurs, flood depths in your neighbourhood will approximately reach 2 meters above street level. A flood depth of 2 metres means that the ground floor of the buildings in your area are under water.

A complication here is that flood depths are not uniformely distributed over geographical areas, and also depend on the threat intensity. Water depths can be presented in flood maps, if available, that enable citizens to infer the potential water depth on their own location. However, research has indicated that people find it difficult to identify their own location on maps (Zhang, Prater et al. 2004). An altenative to maps is to explain the range in water depths per postal code.

Block 6: Evacuation strategy

The sixth block is intended to explain the specific protective actions that should be taken. This information block answers the questions "What specific protective actions should be taken?" and "Are there high-risk groups that require special actions?". One of the three evacuation strategies which has been decided to by the crisis management team can be selected: 1) sheltering in home, 2) sheltering in a public facility within the threatened area, or 3) evacuating to a location outside the threatened area.

Evacuation strategy

If you are in the threatened area you are strongly advised not to evacuate. Leaving the area by car is no longer possible due to high wind speeds. Traffic will be heavy and there is a high probability that you will not have left the area before the flood threat reaches its maximum. You are strongly advised to seek shelter in your home on the second or a higher floor (above 2 metres). If possible, you are also advised to prepare for flooding by doing the following:

- *Warn neigbours and help others in case necessary and possible*
- *Store food and water for at least three days in your shelter*
- *Bring blankets and warm clothing to your shelter*
- *Take a flash light and battery powered radio to your shelter; take extra batteries*
- *Bring personal valuables to the top floor*
- *Turn off the gas, water and electricity before the flood water reaches your home*
- *Do not go out unnecessarily*

Block 7: Information service

The seventh and last information block aims to help citizens to obtain additional information. In the Netherlands, www.crisis.nl is an official government website that can be used by local and national authorities during threats. Local radio stations are also official sources for emergency information. In addition, it is important to inform citizens when the warning information will be updated.

Information service
Additional information can be obtained from www.crisis.nl or by calling 0800-water. Please listen to your local radio station (90,6 FM) which is an official information source. Next report: 10.00 AM.

Block Communication strategy

The prototype version of the FWC allows the communication professional to select two different warning channels; a website format (350 words) and a text message format for mobile phones (93 characters). The selection of suitable warning channels is important, because warning channels differ in their qualities on a number of dimensions. For example, a mobile phone text message warning is:

Flood Alert! Extremely high water at HvHolland (code orange). Follow news! See www.crisis.nl

Text messages on mobile phones can be programmed with a specific alarm tone that is likely to attract attention. However, due to the limited number of characters text messages are less specific than for instance websites, through which authorities can provide detailed information.

NEXT STEPS IN DEVELOPING THE FLOOD WARNING COMMUNICATOR

The FWC is a well working prototype that generates flood-warning messages based on the specifications that are made by its user, preferably a communication professional. Although the FWC has also been based on theories of human response to warnings, there is a number of steps that need to be taken in order to improve the system.

1. Research is required to test and validate warning messages. First, it is important to assure whether the information blocks sufficiently cover the information needs of the warning recipients. This can be done by conducting focus groups or interviews with citizens. Second, the extent to which warning messages are effective in terms of establishing a threat belief, motivating protective action, and making subsequent decisions about the implementation of protective actions needs to be tested. Not only message length, but also language and framing need to be considered. Experimental research in the laboratory and in the field seems the most suitable research methods.
2. The system needs to be adapted to the requirements of its user. Users can vary from local authorities to national authorities. On a smaller geographical scale the warning message can be more specific.
3. Preferably the FWC needs to be able to present graphical information. Also the number of warning channels should be extended, so that messages can be prepared for television, radio, twitter, news papers and face-to-face communication.

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