FLASH FLOOD AWARENESS AND PREVENTION IN GERMANY

D. B. Bung,[1,3] M. Oertel,[2] A. Schlenkhoff,[2] and T. Schlurmann[1]

[1]Franzius-Institute for Hydraulic, Waterways and Coastal Engineering, Leibniz Universität Hannover, Nienburger Straße 4, 30167 Hannover, Germany
[2]Hydraulic Engineering Section, Bergische Universität Wuppertal, Pauluskirchstr. 7, 42285 Wuppertal, Germany
[3]e-mail: bung@fi.uni-hannover.de

ABSTRACT

During extreme storm events rainfall up to several hundreds of millimetres may precipitate in Europe within a few hours. In many cases, limited soil infiltration results in high surface runoff. These flash flood (FF) events can principally occur at any time and place (e.g. in Germany: Bonn-Mehlem 3/7/2010, Oldenburg, 18/8/2010, Osnabruck/Hanover 26/8/2010). While dedicated counter-measures have been developed during the last decades to improve the management of river floods, attention to FF events has not been given in such a great detail. Moreover, due to the very nature of FFs these measures cannot prevent infrastructure from damage. Still, recent projects (e.g. FLOOD*site* [1] or URBAS [2]) deal with FFs, predominantly focusing on forecasting methods using satellite and radar data (e.g. [3], [4]). Furthermore, real-time guidance for flash flood risk management has been developed [5]. Usually the investigations are based on various case studies after occurred events (e.g. [6], [7], [8]). However, compared to river floods no detailed studies are available on the societal awareness regarding FFs and the necessity of prevention measures. The presented abstract is dealing with this identified research deficit. FF awareness and prevention are two main factors to reduce flood damage in urban regions. Next to general hazard identification processes it is essential to get information on the public's awareness to sensitize flash flood events and to result in effective flash flood prevention as well as management plans.

1. INTRODUCTION

Before dealing with flash floods it is essential to distinguish river flood events from flash floods. River floods usually occur in the direct surrounding of watercourses caused by rising river water levels. Hence, their impact area is limited by the topography of the adjoining areas. Return periods can be determined on basis of large data sets and long time-series. Therefore, many counter-measures have been developed during the last decades to improve the management of river floods. These flood types are normally no flash floods.

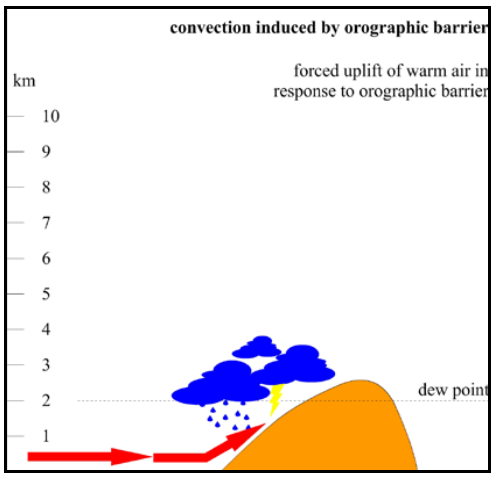
In contrast, flash floods can principally occur at any time and place but are generally intensified in sealed urban areas and thus, involve a high damage potential. The driving forces are usually storm events and resulting extreme rainfall events. During these events rainfall up to several hundreds of millimetres may precipitate in European countries within a few hours. In many cases, limits of soil infiltration, drainage and sewerage capacities result in high surface runoff – so called flash floods.

Flash floods had a worldwide part of around 8 % in all damaging events and 2 % in resulting economic losses during 1980-2003 (MunichRe Foundation). Structural prevention measures and strategies as provided along watercourses against river floods (i.e. dikes/walls and storage reservoirs) do not economically benefit in case of flash floods which are erratic and unpredictable events [9], [10]. Instead, local and very individual protection of buildings with basements and other infrastructure is demanded. Such permanent measures are generally cost-efficient in contrast to potential damages. Benefit-cost analysis for river floods can be arranged at a factor of one, but prevention measures for flash flood events result in a much higher benefit-cost efficiencies.

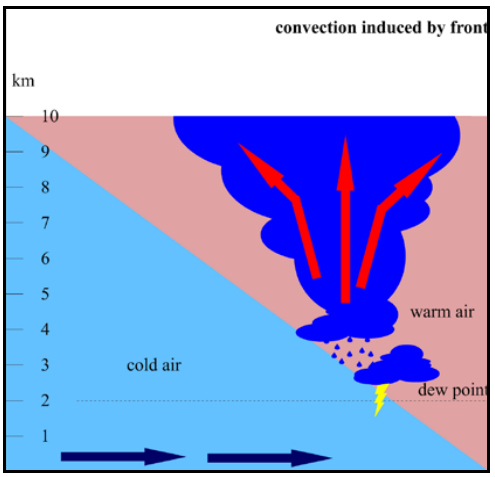
Vulnerability is likewise intensified by exposing more valuable goods and contents and altered uses of infrastructure. For instance, basements and underground infrastructures are more and more equipped with electrical devices, i.e. washing machines, refrigerators and computers. On the other hand, office buildings often come with a basement garage and elevators operated by controllers installed in the basement. The missing awareness of flash floods may be caused by the apparent low probability of occurrence and the short duration of the event. In contrary, the more common and media-covered river flood events are of longer duration and in most cases forecasted with high accuracy several days before a flood wave imperils the specific region and the maximum water level is reached. Thus, a river flood generally attracts more attention and draws additional precautionary measures than sudden, short-term flash flood events.

2. (HYDRO-) METEOROLOGY

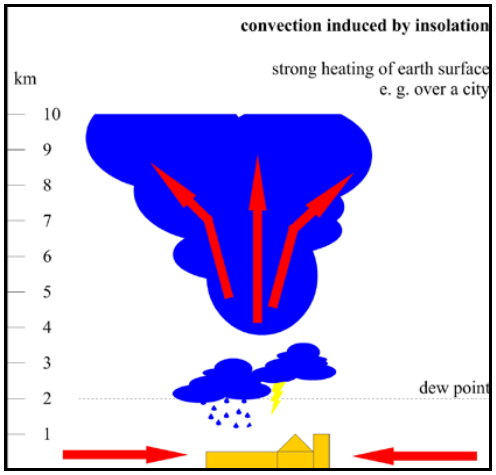
Generally, extreme precipitation scenarios result from storm events with highly concentrated thunder cells running over land areas. Three leading convection scenarios can be defined ([11], see Fig. 1): (a) convection induced by orographic barrier, (b) convection induced by front, and (c) convection induced by insolation. Hybrid occurrences are very likely. In Germany flash floods are mostly induced while storm cells pause unpredictably over indefinite areas and precipitations occur in quasi steady state manner.



a) Convection, orographic barrier



b) Convection, front



c) Convection, insolation

Fig. 1. Definition of convection scenarios [11]

Fig. 2 gives an exemplary extreme storm event over Dortmund in July 2008. The region has an average annual precipitation of approximately 750 mm. In summer 2008 more than 200 l/m² were measured within 6 hours.

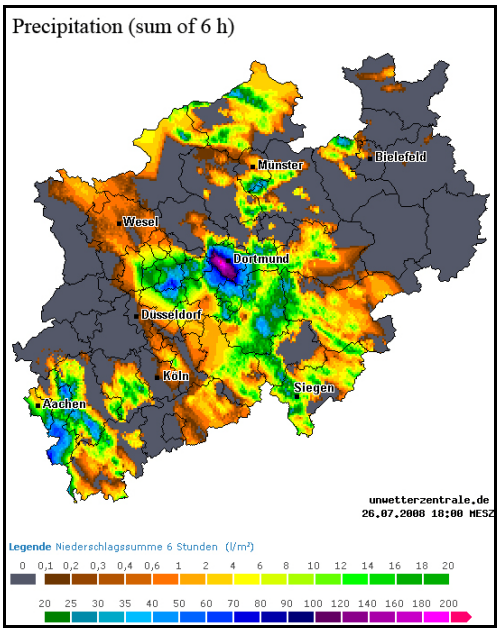


Fig. 2. Precipitation during 6h extreme storm event in Dortmund/Germany, 20/07/2008 [12]

3. DETERMINATION/CLASSIFICATION

Flash flood events can take place in various ways. Generally two main flash flood types are distinguished [11]: (1) the flat land flash flood and (2) the montane flash flood. Both are characterized by different flow and discharge regimes. The flat land flash flood is generally characterized by exceeding local sewer capacities as well as by surface runoff on sealed areas with low infiltration ratio. Generally, flow velocities are slow and low areas are flooded in a quasi-static way. Montane flash floods occur with high flow velocities and damage potential. Erosion, landslides and debris flow are common events. Drainage and sewer systems are blocked up by transported materials and huge amounts of materials remain as deposition. The montane flash flood is primarily characterized by dynamic pressures and forces.

4. AWARENESS – QUESTIONNAIRE CAMPAIGNS

To get a current impression of local awareness levels questionnaire surveys are arranged [13]. The strategy provides two main interest groups: (1) local citizens to research general flash flood knowledge and awareness, and (2) local water authorities, fire departments and federal agencies for technical relief to analyze preventative measures. This paper deals within a first step with questionnaire surveys for local citizens in four regional cities: Wuppertal, Dortmund, Cologne, and Düsseldorf (see Fig. 3). The cities are located in the most populated area in Germany with more than 1,000 inhabitants/km^2. All cities, except Dortmund, are located in flat lands close to rivers or tributaries of larger rivers. Results are based on following quantities of questionnaire campaign feedbacks:

Tab.1. Quantities of questionnaire campaign feedbacks.

Overall	Wuppertal	Dortmund	Cologne	Düsseldorf
339	135	60	72	72

A total of 34 questions are asked. These questions are arranged in five blocks: (I) general questions on habitation, (II) general questions on natural phenomena, (III) specified questions on floods and flash floods, (IV) general questions on questionnaire campaigns, and (V) personal questions.

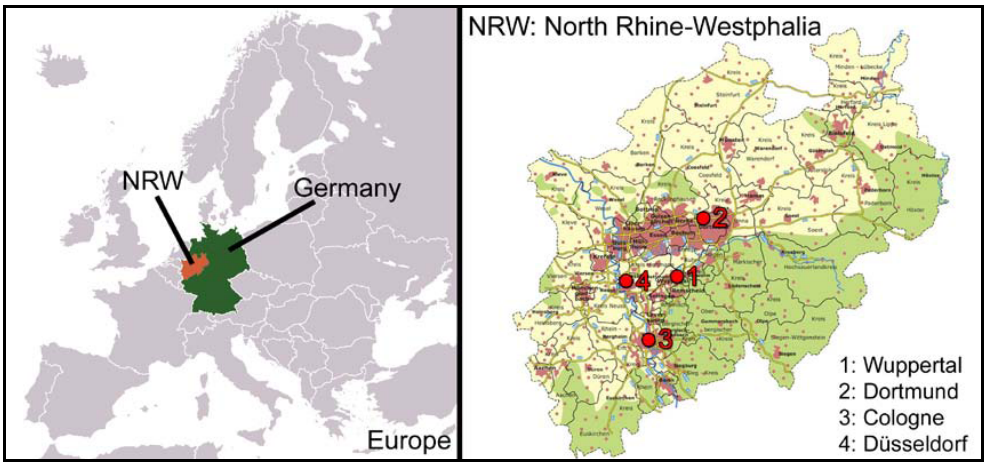


Fig. 3. Location of questionnaire surveys in Germany in March 2009

The results show a good spreading in regard to gender, age group and persons per household. To detect possible information sources questions like “Do you read daily newspaper?” and “Are you member of a local club?” were asked. Here 3/4 read the local news in daily newsletters but only 1/4 are members in various clubs. More than 85 % have a main interest in natural phenomena. Questions on residential areas show very good hit rates of local inhabitants, which the questionnaire surveys focused on. Fig. 4 shows the habitation character, where more than 50 % are living in imaginable flash flood affected houses with basements/ground floors – and nearly 60 % of the people are living in their homes for more than 5 years. The question if there is a river or stream around was answered with “no” by 73 % of the interviewed people. Here, it can be assumed that many of them do not know especially about small creeks which might run in underground channels. A main output gives a question dealing with past house flooding events. As illustrated in Fig. 5, nearly 1/4 of the interviewed people already have been affected by flooded basements or ground floors (16 % due to heavy rainfall and only 3 % due to a river flood). Reviewing the city of Dortmund separately (here, an extreme event occurred in 2008, Fig. 2), this value increases up to 25 % only affected by heavy rainfall. Even more dramatically is the number of known affected people. Fig. 6 illustrates that 45 % have affected relatives or neighbors. 44 % of affected people invested in resulting protection measures (Fig. 7) – mostly in backflow flaps, sewer cleaning and pumps. But only 42 % of the damage has been insured (Fig. 9). Damage amounts are generally smaller than 1,000 EUR. But also larger damage amounts were detected. For instance, 6 % of affected people sustained damages of more than 20,000 EUR.

Questions like “Do you think you can be affected by floods / flash floods?” are in the focus of interest in order to detect the people’s awareness. For 41 % of interviewed people think to be generally at risk. Continuatively, the terms “flood” and “flash flood” are prompted to be explained. While 97 % know about “floods” and give the correct answer on the meaning, only 71 % pretend to know about “flash floods” (Fig. 10). In fact, after several personal consultations it can be assumed that many interviewed people never heard about it before. When clarifying the term it was classified the right way (Fig. 11).

Fig. 12 gives the results for detected information sources in regard to flash floods. For flood as well as for flash flood events TV, newspapers and friends are nominated as main sources. Results of questions on informative meetings as a main flood protection measure are given in Fig. 13. For floods 60 % just did not know about the existence of meetings. For flash floods these are 65 %. Here, a large leakage of knowledge has been detected. Mentionable is the number of people which think a flash flood can affect them. 50 % declared “already been affected”, “definitely” or “imaginable” (Fig. 14). But the question on existent insurances has been answered with “no” by approximately 50 % – for floods

as well as for flash floods (see Fig. 15). However, more than 50 % remarked the desire for more informative meetings and more general information.

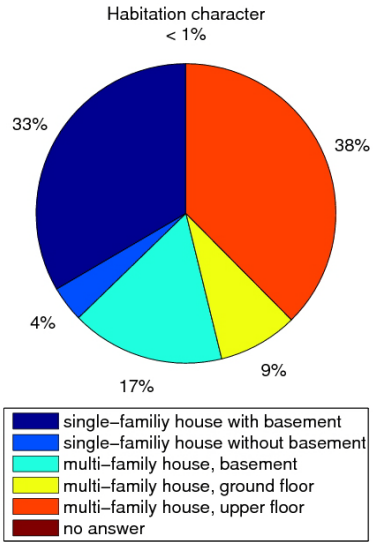


Fig. 4. Habitation character

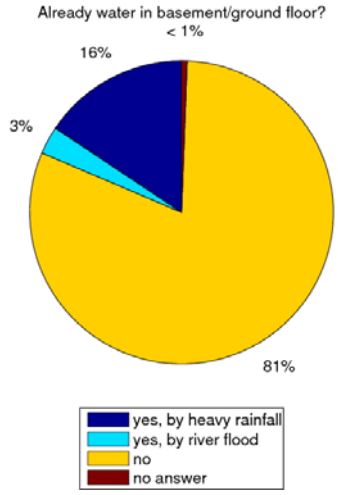


Fig. 5. Water in house

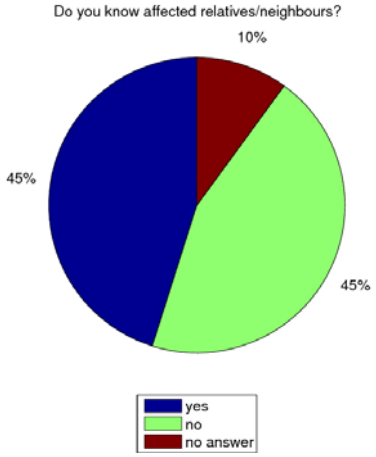


Fig. 6. Knowing affected

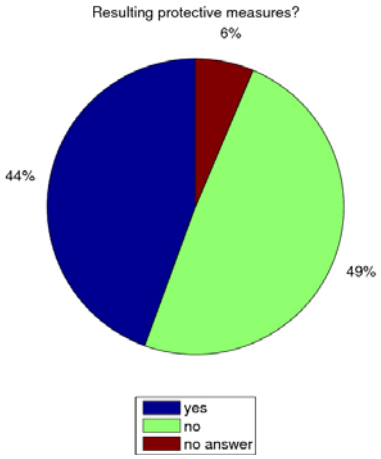


Fig. 7. Protection measures

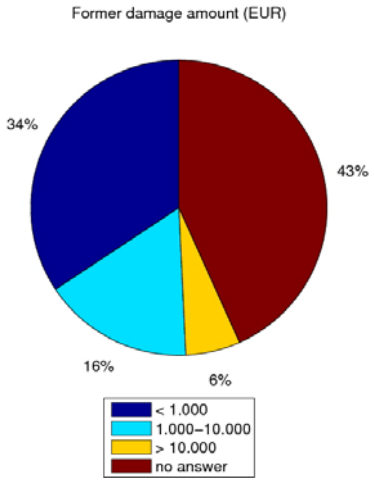


Fig. 8. Damage amount

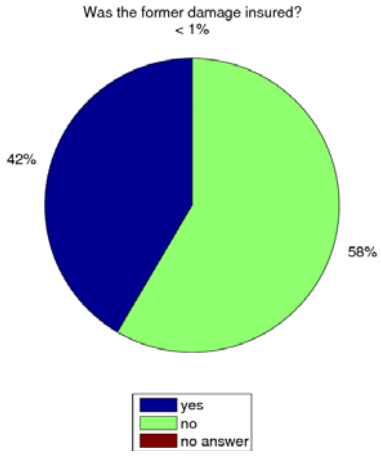


Fig. 9. Insured damage

5. PREVENTION

To be prepared for flash flood events several measures are conceivable. In accordance with national and European flood protection strategies for river flood events [14], these can be distinguished as follows: (1) technical prevention, (2) flood area management, (3) risk or financial prevention like insurance, (4) information prevention, and (5) building prevention. As a result of the arranged questionnaire surveys there are two main prevention measures for flash flood events which have to be carried out:

1. Clear definition of the term “flash flood” and connection to flood events caused by heavy rain falls, and
2. Arrangement of informative meetings and general information prevention measures (e. g. flyers in daily newspapers, TV documentations etc.) to prepare the people for possible events. Here, information on technical prevention and building prevention measures as well as on financial prevention measures must be discussed in detail.

Hence, main flash flood prevention measures can be arranged in the information prevention methodology in combination with small technical prevention measures. A fundamental knowledge about private sewage systems and technical components (e.g. backflow traps and drainage systems) is absolutely necessary to be protected for lots of flash flood events. These small prevention measures can help reducing resulting damages with only small investigations.

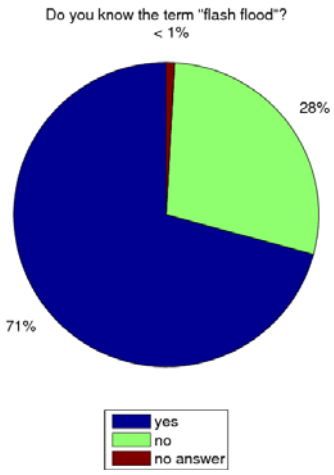


Fig. 10. Term "flash flood"

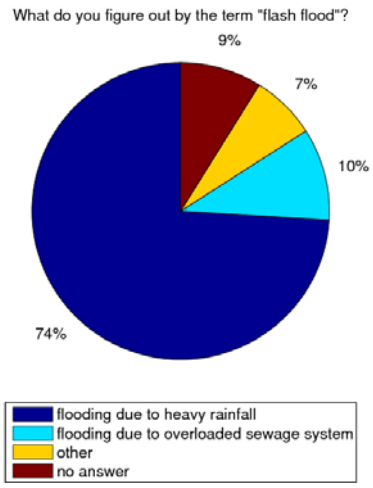


Fig. 11. Classification

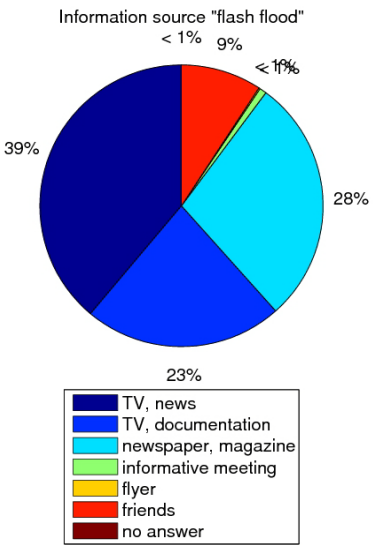


Fig. 12. Information source

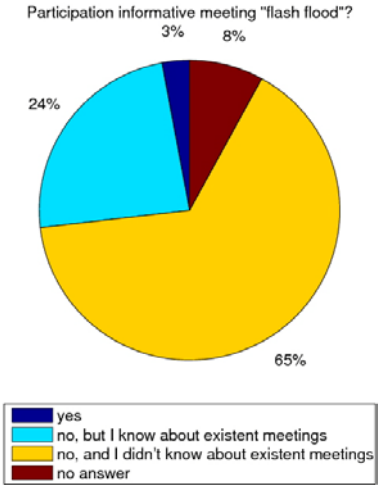


Fig. 13. Inform. meetings

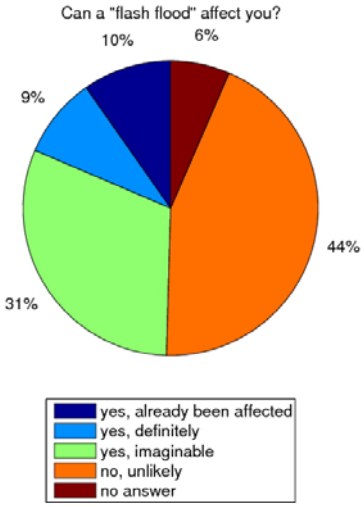


Fig. 14. Might be FF affected

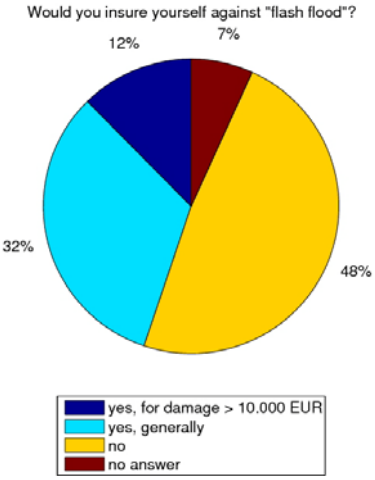


Fig. 15. Insurance

6. CONCLUSIONS

In summary, the survey reveals that flash flood awareness is lacking in Germany. There is no knowledge about informative meetings and available information materials. On basis of desired informative meetings, information prevention measures must be communicated to the population. Past events show that more than 50 % have already been affected or at least knowing affected people. Before considering technical measures for protection and prevention of damages due to flash floods, this public awareness needs to be properly raised in order to ensure an efficient flood management strategy. Public information initiatives calling for optional closing of natural hazard insurances, as recently carried out by the Bavarian State Chancellery, are demanded for broader mainstreaming of knowledge and expertise in other federal states as well as on the European framework level to help efficiently reducing disaster risks stemming from flash floods in the future.

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