Chapter 10

Education and information as a basis for flood risk management – practical issues

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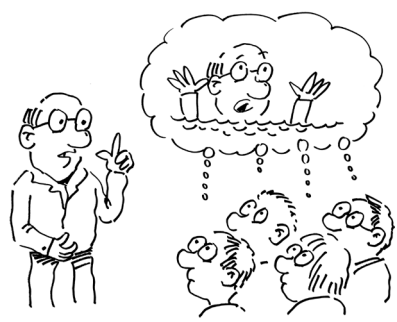
10.1 WHY FLOOD EDUCATION?



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Judging by the increasing flood damage in nearly every country, one can state that no country copes satisfactorily with floods. Hence, flood risk reduction is an extremely important need, and flood-related education plays an essential role in development of flood risk management plans.

The importance of flood-related education has grown with the change of flood risk management strategies in recent decades. In the past, when society was convinced that engineers were able to free the nation from flood risk, flood-related education and awareness were of minor significance. Engineers or experts clearly knew what to do, and society expected to benefit from their work. However, over time, it turned out that despite the huge investment in structural flood defenses, the damage occurring has not declined. Quite the opposite, it has been growing, for at least two reasons. First, the ability of embankments and reservoirs to provide complete flood protection has been overestimated and only the *illusion* of safety remains. Second, flood-prone areas have been increasingly developed as a consequence of the illusion that structural defenses offer adequate protection. However, many specialists express the opinion that floods cannot be eliminated from our lives. One can only reduce the damage that floods cause.

In the light of the above-mentioned paradigm change, we assert that the present volume shows numerous weaknesses people have when it comes to an awareness of the risk, a knowledge of how the risk can be limited, the motivation for protection against the flood, etc. People often take a substantial risk by building on flood plains, yet inhabitants of vulnerable areas are hesitant to purchase even subsidized insurance products. They do not know how to prepare for a flood or how to behave when a flood strikes. And they do not know how to lobby for adequate flood preparedness. There is no doubt that both residents of vulnerable areas as well as local and central administrators strongly need education on issues of flooding (and other natural hazards). Unfortunately, the main trigger for improvement of flood risk management is the occurrence of a large flood. And during periods when no large floods occur, improvements in flood preparedness get lower priority. The same scheme applies to interest in education among vulnerable communities. Thus, an obvious challenge is what to do during a period without large floods (that come rarely) in order to maintain interest in flood preparedness.

Figure 10.1 clearly illustrates the effect of a large flood as a reminder to invest into flood preparedness using as an example funding flood-related research in Poland. There were few flood-related projects starting every year before the occurrence of the Millennium Flood (1997) because of the preceding flood-free period. In fact, there were no flood-related projects commencing in 1997 at all. But the number soared in the year after the flood, only to gradually decrease thereafter.

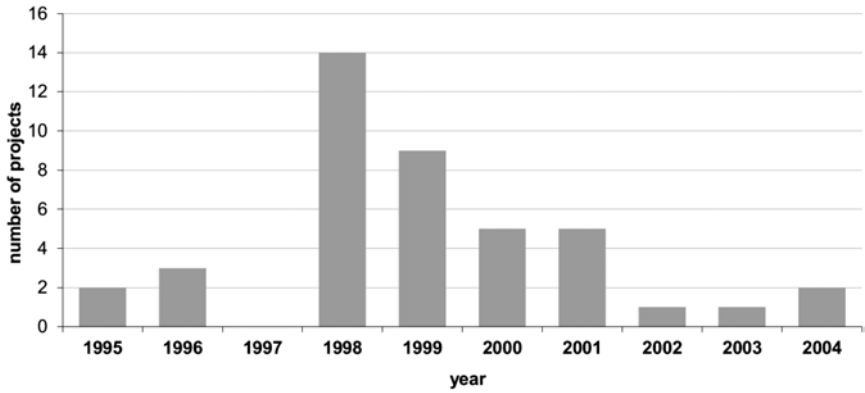

Figure 10.1 Number of flood-related research projects in Poland funded by KBN (Committee of Scientific Research) commencing in particular years. In 1997, when no new flood-related project was initiated, a very dramatic flood event occurred.

10.2 ACTORS IN THE FLOOD RISK EDUCATION AND COMMUNICATION PROCESS

There are many groups of potential actors in the process of flood risk education and communication: those who initiate action ('broadcasters') as well as those who receive information and knowledge ('receivers'), including those who are directly affected. Some stakeholders are formally required to manage the risk or mitigate the impact of floods. Others do not have such a formal obligation but are interested in the process because of the objectives of their institutions. Yet another group can be labelled 'communication intermediaries.' The number of process-related entities is huge, especially when also considering the administrative level of these institutions (national, regional or local). Brief characteristics of the main groups of participants in this process are given below.

10.2.1 Broadcasters

10.2.1.1 Institutions responsible for flood risk management

There is no single model of flood risk management worldwide. Various institutions are responsible for flood risk management strategies and their implementation. There can be water agencies, financially independent from the state (e.g., in France), institutions within the standard administration structure (e.g., in Germany and Poland), environment agencies (e.g., in England and Scotland), or specialized institutions such as the Federal Emergency Management Agency (FEMA) in the

USA. Usually these institutions have a huge impact and high competence in the fields of education, promotion, and public participation in strategy building.

10.2.1.2 National weather services

Weather services operate in each country. Their tasks include the gathering of data on weather parameters (rainfall, temperature, wind strength and direction, etc.) and water levels and, using these data, preparing forecasts of precipitation and water levels in rivers. This information is important for the safety of citizens and the economy.

10.2.2 Communication intermediaries

10.2.2.1 Non-governmental organizations

In different countries there are non-governmental organizations (NGOs) which are active in the process of risk education and communication with the public. Some of them cooperate with schools, providing knowledge about the rivers, their significance, and the importance of the environment. There are also organizations that assist local governments in the preparation of local flood plans and flood-related education.

10.2.2.2 Schools

Schools communicate a basic understanding of natural phenomena, including floods and their causes and effects. Schools, together with traditional media (radio, TV, press) or social media are considered to be the main intermediary in the transmission of knowledge and awareness to prepare for a variety of disasters, including floods, and to shape safe behavior during and after a flood. This applies not only to the education of pupils but also to the education of adults through the children – with many school programs being addressed also to the families of pupils.

10.2.2.3 Mass media

The media (press, radio, TV, Internet) play many different roles, related to information, explanation, entertainment, education, and control. Local media focusing on a small area are necessarily closest to the problems of the local community which is the principal recipient. Hence they are willing to cooperate in this field with specialized organizations such as crisis teams or water institutions (Podraza, 2003). Regional or national media focus more attention on general problems and perform control functions in relation to public institutions more often than local media.

10.2.3 Receivers

10.2.3.1 Threatened residents

As can be seen from surveys and interviews conducted in various locations in regions where floods occur relatively frequently, the residents are quite familiar

with this hazard. They also try to prepare for it and undertake preventive measures on their own initiative. However, in many other regions where floods occur only occasionally, residents are taken by surprise and learn about the threat only when a flood occurs. Generally, although not always, local governments efficiently inform residents about the threat and the local response and evacuation plan. In some countries, knowledge of the subject is for the most part low. But there are also countries (e.g., the United Kingdom) where access to such information is very good.

10.2.3.2 Administration

This category embraces national and local governments. The task of flood protection is carried out by the water administration (water agencies) while the tasks related to preparation for the flood response and after-flood recovery are performed by the state administration and responsible governments at all levels. In crisis management plans prepared within this structure, floods hold an important place in the context of warning, preparedness, flood management during the event and after-flood recovery. In some countries there are regulations, according to which plans do not require cooperation with local communities. Some governmental entities at the regional level undertake educational activities addressed to schools and local governments.

Unfortunately, often both the regional and the local administrations have relatively little knowledge about flood risk management. They need at least as much information and education as residents.

The general categories of actors in the education process as described above may overlap, in that representatives of each of them also play a role in other categories.

In practice, the situation is much more complex, so that a rigid division between those who have knowledge and disseminate it and those who do not have it and wish to receive it is deceptive. The flood education system should be viewed differently than a traditional hierarchical system of basic education, whose aim is a one-way flow of knowledge and information from professional institutions to ordinary people (Kuhlicke *et al.* 2011). Individual entities have, in fact, their own experiences, without which others could not successfully perform their tasks. For example, the experiences of people who have suffered a flood provide valuable information for local emergency services and planners due to the fact that they include actual information about the sources of flooding, its course, and its consequences. All this information is essential for effective planning. In turn, the emergency services and planners can potentially provide the affected parties with knowledge about appropriate methods of reducing flood risk in all phases of crisis management. Consequently, one can state that to some extent all the actors are both broadcasters and receivers of the knowledge. Such a situation means that the system of flood education should be based on two-way communication, taking into account the knowledge and experience of those at risk and allowing the exchange of experience and participation in raising awareness.

10.3 OBJECTIVES OF FLOOD-RELATED EDUCATION

The goal of flood-related education is to improve the awareness of threatened entities and their activation in the process of preparation for a flood. This can be achieved by providing access to information and balanced knowledge to the main actors who can contribute to flood risk reduction and by enhancing the exchange of experiences and various forms of cooperation among them.

The realization of these objectives naturally brings problems. For example, it is often more and more common that property owners are educated by NGOs, but they are neither understood nor supported by their local self-government, who lack relevant knowledge and continue to work on the basis of traditional risk management rules (e.g., in Poland). Similarly, it happens that local governments which are trained may attempt to change the strategy, but they are restricted by rules created and controlled by the central administration. Regardless of these difficulties there are three crucial education aims to be achieved. These are to ensure that stakeholders:

- Are aware and have knowledge of the local flood risk, its sources and the scale of the hazard, and its consequences;
- Are aware that they have the ability to take measures to limit the threat to life, health, and property, both at the individual level and the level of the community in which they live or work;
- Know the institutions that can assist them at different stages of preparation or response to the flood and are willing to participate in the preparation and implementation of measures to increase the resistance and resilience of communities.

10.4 CONTENT OF FLOOD-RELATED EDUCATION

Knowledge useful for coping with flood risk and reducing losses covers many different topics. A number of them have been raised in earlier chapters of this book. The change of paradigm of risk management considerably broadens the scope of the assistance needed by vulnerable subjects.

So far, the dominant paradigm in disaster risk management has focused on the physical course of phenomena that threaten people and on finding methods to protect them against the threat. Scientific knowledge and engineering have been used, aiming to subordinate the forces of nature to man and to help reduce flood losses. This was a top-down approach – decisions being taken by representatives of authorities and experts – and the residents had to obey. The new philosophy of risk management assumes that the danger cannot be eliminated, so all one can do is to limit its adverse effects. The perspective from below should be taken into account (a bottom-up approach) through the participation of vulnerable communities in deciding on issues of concern to them. This also will take into account useful local knowledge. In this new paradigm, the key actions respect nature, making use of natural strategies (e.g., reducing the risk by protecting natural retention, especially

the riverside areas, and reducing exposure by avoiding managing floodplains), reducing the vulnerability of buildings and communities at risk, and increasing the resistance of the residents of areas at risk through individual preparedness (Mercer *et al.* 2008; Fordham *et al.* 2013).

Proposed new strategies of coping with floods resulting from the new paradigm make use of knowledge from various disciplines, ranging from the area of engineering to the social and economic domains. This requires integrating knowledge from many different areas (natural, social, psychological, technical and economic sciences as well as climatology and many others). But it is not enough to simply conclude here that employees of the administration themselves should possess more knowledge in these areas than ever before. It is also necessary that they are capable of monitoring the situation 'at the bottom' in their work and making use of the information. They should be able to gather and analyze assessments and experiences of affected communities, especially those concerning the causes of losses and the effectiveness of various methods of risk reduction. Only then they will be able to effectively discharge their responsibilities.

Basic flood-related education should incorporate:

- The main characteristics of the flood hazard;
- Knowledge of local causes of floods;
- Flood risk reduction measures.

The scope of information in each of these areas of expertise should be different depending on to whom it is addressed. For example, residents should get information about the threat (flood risks and the water depths), while local administration or government should get information on the type and number of objects in individual zones, the estimated amount of losses etc.

10.4.1 Main characteristics of flood hazard

Many residents and users of floodplains are not aware of the threat of flood risk and its possible extent and size (probability of incidence, depth of the inundation, and velocity of water). This information is naturally the basis of all necessary preparatory measures.

One can assert that the means for improving the awareness of people today is much better than a few years ago. Currently, many countries ensure public access to the maps of flood extent for several incidence probabilities. In the European Union countries such maps, for floods of different probabilities of severity (labeled as rare, medium rare, and common) have been available since 2013, according to the requirements of the Floods Directive (Directive 2007/60/EC, 2007). They allow ordinary people to see whether they live or work in areas at risk of flooding. A separate product available in the EU countries is a collection of maps showing the development in these areas and the potential losses that may result if flooding arises. This is necessary information for the purpose of building a strategy and creating plans for flood risk reduction.

Such maps – especially those showing the flood extent of varying probabilities of incidence – can facilitate the process of education, communication, and planning. Maps are very effective educational tools, sparking one's imagination, and they may lead to a completely new perspective on the problems. The main issue is to ease access to maps for ordinary people. In some countries access to maps for non-experts is very difficult. Examples of user-friendly solutions can be found in England and Scotland, where the map covering the area of interest can be searched in the system in a user-friendly manner by place of residence or by postal code.

A completely different form of information on flood hazards in an area of concern entails collecting and sharing historical information about past floods and their effects and the use of flood (high-water) marks to communicate with people. For ordinary people, the historical high-water marks can be more trustworthy than maps of water depths and their probabilities of being exceeded. However, gradual changes in land development and the construction of technical flood protection structures (dikes, reservoirs, etc.) could considerably change the flow regime (and the stage-discharge relationship).

This traditional way of presenting historical data seems to be communicated well; indeed, some risk management institutions actively support it. The American FEMA launched a program of co-financing the placement of high-water marks by local communities (FEMA, 2016). In Kraków, the City Council funded the revitalization of the existing historical high-water marks indicating how high historical flood levels were and publishing a guide to such flood marks.

10.4.2 Knowledge of local causes of floods

There are common myths and misconceptions about floods and other natural hazards. For example, people generally consider that flooding is a phenomenon closely related to the river when in fact there are many other types of flooding. Contrary to common belief, research run in Poland in 2013 (Analiza obecnego systemu …, 2013) on several hundred municipalities showed that the greatest losses related to water abundance include the runoff of rain water on the land surface (63%) and a rising groundwater level (61%), with river flooding only ranking third (45%).

People also envisage floods as natural disasters caused by forces of nature, although human influence on flood risk (deforestation, land surface sealing, river channelization, inappropriate drainage) has long been known. The selection of appropriate methods of prevention or response depends on understanding both the type and the cause of flooding.

Education should convey the message that floods can be caused by various mechanisms and that each of them may have a different – and often unique – set of measures to limit its impact on the health and lives of people and on the economy. There is no single, coherent, and agreed upon taxonomy of floods. Most common classifications refer to the origin (rainfall, storm, snowmelt, ice jam).

But for education aimed to aid in reducing flood risk, one could distinguish five categories: river floods (including dike breaches), land surface flooding, flash floods, groundwater floods, and sewer floods.

Two of these types of floods are quite different from the risk reduction viewpoint: flash floods require the cooperation of many institutions in order to limit losses, while sewer floods can be prevented in a simple manner.

In many countries, flash floods are separated from the category of river floods and are especially dangerous and can cause numerous fatalities. They are defined as floods which result from short-term, rapid precipitation. The time between the occurrence of precipitation and the maximum water level can be less than 4–6 hours.

In southern Poland, flash floods play havoc, for example in July 2003 on the Wilsznia Creek (a tributary of the Wisłoka) when a local flood lasting several hours killed six people traveling in two cars. The property owners in the area suffered virtually no losses, and those who died were incomers who did not know the area and the threats. Counteracting the effects of flash flooding requires special measures (accurate forecasts and the development of rainfall and water level monitoring systems) and the close cooperation of many institutions ranging from meteorological and hydrological services to local governments and residents.

Another special kind of flooding worth noting is a sewer flood, being the effect of reversing the wastewater or rainwater sewage network. Contrary to common knowledge, such events are not rare. According to a report of floods in 1993 in the USA (Interagency Floodplain Management Review Committee [IFMRC], 1994), only half of the objects damaged by the floods were caused by water flowing over the land surface. The others were flooded by groundwater and sewers. Most important is that sewage floods can easily be addressed by installing low-cost measures (sewer pipe shutters or non-return valves).

In some countries, most of the flooding, including frequent inundation by small watercourses and common flooding of roads because of blocked ditches or defective drainage systems, is ignored. Damage is so small that it is not interesting to decision-makers or the media. However, these small losses add up over the years, such that total global losses from small floods are comparable to those from large ones.

Finally, floods and their frequencies are commonly attributed to natural factors; however, the truth is that the increasing flood losses are often caused by human factors such as the mismanagement of natural areas (elimination of wetlands, removing trees and shrubs in watersheds). In areas at risk, the intensification of development, sealing of surfaces, and lack of preparedness of constructions to inundation (e.g., via rigorous building codes and their enforcement) contribute to increased flood risk. The causes of flooding classified into natural and anthropogenic factors are shown in Figure 10.2.

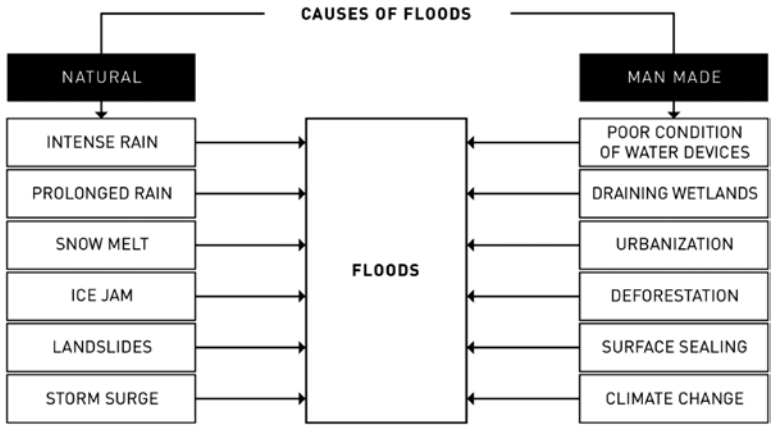

Figure 10.2 Examples of causes of flooding, divided according to mechanism (natural versus anthropogenic).

10.4.3 Flood risk reduction measures

The new paradigm, according to which flood risk management relies largely on limiting the potential effects of floods, opens up a wide range of different (new) methods of application. Figure 10.3 presents a list of measures which reduce flood risk together with the responsibilities for their implementation.

The first group of measures concerns the **reduction of the extent of flood hazards**. The hazard and extent of flooding can be limited by applying measures to increase water storage (natural or artificial). It is advantageous to use natural methods – protecting green areas, wetlands and swamps, allowing sufficient space for the river, and avoiding the sealing of surfaces. Engineering structures such as reservoirs, levees and relief channels are commonly used for this purpose. To control smaller floods, regulating river channels reduces the extent of floods. This is a strategy of *'keeping water away from people'*.

The second group of measures concerns the **reduction of exposure to floods**. Losses can be reduced by taking actions to restrict the development of floodplains by banning the construction of some types of structures (e.g., hospitals, nursing homes, chemicals warehouses, landfills), specifying the conditions for constructing other types of buildings, and possibly buying out and decommissioning the most vulnerable structures. This is a strategy of *'keeping people away from the water'*.

Finally, there are measures for **reducing vulnerability to floods**. The vulnerability can be limited by effective preparedness. Contrary to widespread opinion, individuals, communities and governments can do a lot to limit the adverse effects of floods. The options range from retrofitting houses, to effective early warning systems and response teams to flooding, to flood insurance. An important aim of flood-related education is to disseminate knowledge about the simple ways

of limiting the effects of floods. They require neither special efforts nor significant costs. Usually they are common sense methods – if we know which way the water can get into the house and why, we can take precautions. For example, closing windows and doors to the basement and closing the aforementioned valves on the sewage system or other such arrangement in a house can mean that the flood water is only able to destroy things of small value (with valuable things placed permanently on the upper floors). This is a strategy of *'learning to live with floods'*.

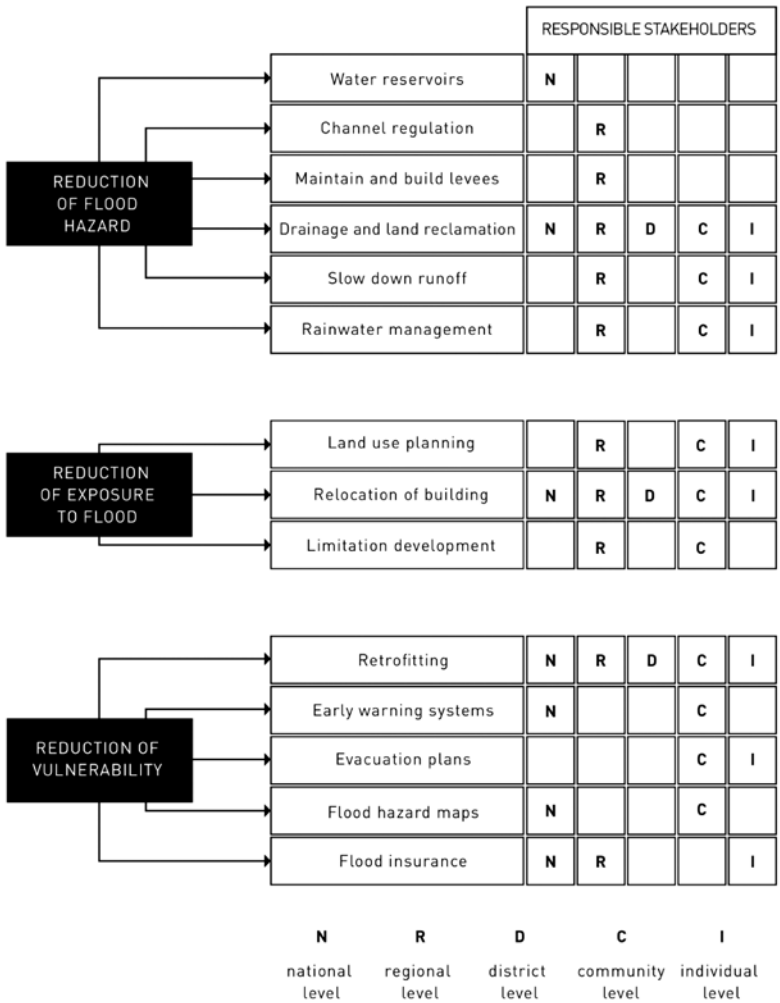

Figure 10.3 Methods of flood risk reduction and responsibilities for their implementation. (N – national level, R – regional level, D – district level, C – community level, I – individual level).

The term 'responsibility' used in Figure 10.3 means the responsibility imposed on the actor by law or by unwritten rules or customs applied in practice. It does not include such activities as the design and implementation of instruments for the implementation of risk mitigation measures, which are usually the responsibility of the national or state government and perhaps to some extent local government.

It is worth noting that only very few of the activities described in the framework of the strategy are in the hands of the government. This applies generally, but not exclusively, to measures to reduce exposure and vulnerability. This is because those implementing this system are independent of each other. The state administration, obliged to draw up flood risk management plans, does not have the tools or the coercive measures with which it may affect them. In such cases, parametric management systems are useful, where those objectives can be achieved using various so-called 'soft' instruments of encouraging the individual parties to undertake specific actions. These instruments may include financial incentives and penalties along with organizational and informational measures. The role of the state and other decision-making bodies in the system is limited mainly to the creation of these instruments and to monitoring the results of their implementation. Flood-related education and access to information about floods and methods of damage reduction are key instruments which, while not limiting the risks themselves, do facilitate or encourage different groups of actors to take appropriate actions in line with the established objectives.

10.5 PROBLEMS OF PARTICULAR IMPORTANCE

A sample of issues presented below should be important in education on floods, but they have more to do with a change of awareness and habits than with the transfer of relevant knowledge. They require a special approach, that is, special methods of presenting them within the education process. These are:

- Responsibility for safety;
- Illusion of safety;
- Communication of risk.

10.5.1 Responsibility for safety

Responsibility for flood risk reduction should be shared by multiple constituencies, including the residents of the flood risk prone areas (who should prepare their homes for flooding).

The traditional system of flood risk reduction sends a clear signal to those at risk that the protection of their health, life, and belongings during the flood is being dealt with by the state. This belief began to weaken when, after many years of large investments made by administrators in technical flood defenses (storage reservoirs, embankments, relief canals and channelization of rivers), it turned out that losses were still rising. People began to notice that the dikes were often ineffective (they

could be overtopped or breached), reservoirs were not always able to 'catch the flood,' and channelization of rivers did not protect against flooding but just against (bank or bottom) erosion. Regardless of these failures, acceptance of the philosophy that everyone is responsible for their own family, employees and property is not widespread. Consequently, despite the many discussions and publications and despite the new way of managing flood risk introduced in many countries, many people at risk are still convinced that the state is responsible for their safety. According to a report prepared after the catastrophic floods in 2007 in the UK (Learning lessons …, 2008), 46% of the surveyed residents stated that they did not intend to take specific safety measures because the state should protect them. There is a common belief that structural defenses are the most effective flood protection measures, and these lie within the domain of administration, beyond the reach of individuals. Hence, many individuals feel that flood protection does not fall within their purview.

Even more troubling results were obtained in Poland, where after the flood in 1997 in Brzesko only 28% of people responded that they themselves can protect their assets against flooding (which does not mean that they in fact did). The rest expected this from the community (85%) or the state (37%) (Konieczny *et al.* 1999; Działek *et al.* 2013). Consequently, even experiencing disaster, loss of property, and/or traumatic memories does not encourage most people to take action. Research shows that such measures are taken on their own initiative by only about 10% of the people at risk. This is confirmed by research carried out in Poland and Germany (Kreibich *et al.* 2005; Konieczny *et al.* 2016). Clearly, where flooding occurs often, homeowners tend to invest in security.

This should ultimately be specifically delineated in the law, as it is in England and Scotland. In the flood-related information on its website (Scottish Environment Protection Agency [SEPA], n.d.), the Scottish Environmental Agency states bluntly: 'It is your responsibility to manage your own flood risk and protect yourself, your family, property, and business'.

An American initiative, the so-called Community Rating System, encourages owners of property to take preventive action, and it rewards those who do so with a reduction in their premiums for flood insurance offered by FEMA.

10.5.2 Illusion of safety

In many countries, protection from river floods relies heavily on structural defenses – dikes and water storage reservoirs – often built for multiple purposes in addition to flood protection. Existence of a structural defense is perceived by the riparian population as a guarantee of safety, so that considerable wealth is accumulated in apparently protected, but in fact flood-endangered, areas. Even if dikes are in place, they offer limited safety only – losses soar when extreme flooding overcomes structural barriers. Every dike can be overtopped and/or breached. Hence, flood damage in a levee-protected landscape is likely to be higher than it would have been in a natural (levee-free) state, where damage potential is significantly lower.

For example, most of the damage caused by great floods that occurred in Poland in the last 20 years occurred in areas protected by dikes.

Structural defenses are treated as flood protection measures that *guarantee* security, whereas in reality these defenses are designed based on statistical analyses. It is common to assume that they should be able to withstand river discharge up to a certain magnitude (e.g., a 100-year flood, with a return period of 100 years and a 1% probability of occurring in a single year). Statistical design means that a levee may fail if the flood is more extreme than the design value. Hence, even a perfectly maintained dike designed to withstand a 100-year flood does not, by definition, guarantee absolute protection. It is simply not possible to build structural flood protection that is sufficient for extremely rare events. No matter how serious a flood the dike is designed for, there is always a possibility a greater one occurring. So should dikes be designed to withstand a 100-year flood or should a much more robust dike be built, withstanding a 500-year flood? The latter solution should give a better protection, but at a much higher cost. Even that one would likely turn out to be insufficient if a 2000-year flood arrives. Dikes are effective and offer adequate protection against small and medium floods – and the number of *damaging* floods in this range is indeed decreasing as a result (Kundzewicz, 1999) – but in the case of large floods dikes give us only more time to escape.

Figure 10.4 presents the four-stage cycle (positive feedback) of the phenomenon known as the 'levee effect' (Tobin, 1995). It starts with the construction/strengthening of levees along the river. This results in improved protection of areas behind the levees against small and medium floods, so that property owners feel safer and undertake development behind the levees. However, if a flood is much higher than the design flood, the levee is likely to fail – hence the notion of illusion of safety. Due to development of areas behind the levees, residual flood risk increases, which eventually leads to another round of construction/strengthening of levees as per the cycle illustrated in Figure 10.4. Bearing in mind the illusion of safety provided by structural means, the 'levees-only' solution has been challenged by advocates of nature-based solutions, described by the slogans: 'living with floods', 'giving room back to the rivers', or 'moving out of harm's way' (retreating from unsafe areas).

Of course these all sound very good, but it is much easier to pay them lip service than it is to take meaningful action to implement them. After all, they can be costly and inconvenient. It is imperative, then, to 'strike when the iron is hot,' that is, to put such proposals into practice when the public is most likely to be actively supportive. A serious flood in the Midwestern United States provided just such an opportunity to relocate residents away from vulnerable locations in the Mississippi River Basin flood plain. In fact, such a relocation program has been implemented in the USA after the Midwest flood of 1993. The US IFMRC (IFMRC, 1994; Galloway, 1999; Kundzewicz, 1999) issued a recommendation that the authorities (federal and state) should fund the acquisition of properties at risk in the flood plain. The number of families voluntarily relocated from vulnerable

flood plain locations in the Mississippi Basin reached 20,000. The success of this relocation program can be interpreted by consideration of several aspects. The scale of the 1993 flood was disastrous. Some of these properties had been flooded before, so that their owners were convinced to leave and relocate to a safe place, even more so if the proposed price was fair (it was indeed, corresponding to pre-flood conditions). Moreover, there was a good coordination of actions of various federal, state, and local agencies.

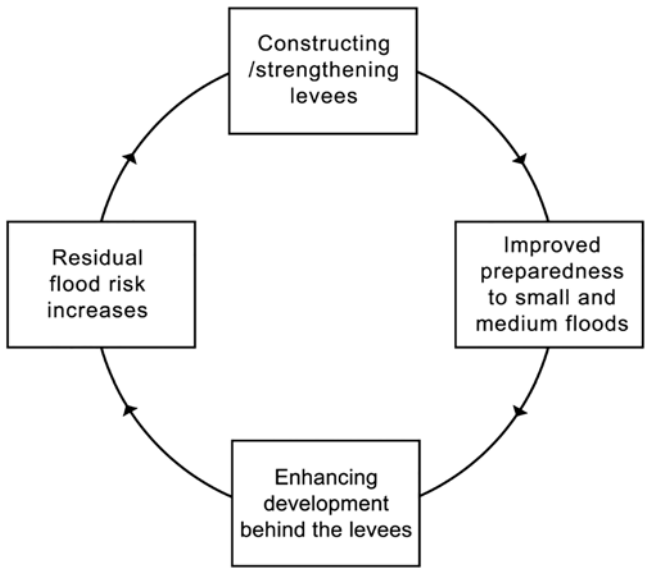

Figure 10.4 Flood safety illusion scheme.

10.5.3 Communication of risk

A very important problem in flood-related education is the selection of an appropriate vocabulary to describe the philosophy of risk reduction methods, including illustrating the likelihood of flood occurrence.

At first, the term '100-year flood' was used, but it turned out that a significant percentage of people treated it as information about the incidence of flooding rather than an average frequency of its occurrence. Hence, experts began to look for a different narrative. The US National Academy of Sciences (National Research Council [NRC], 2000) and FEMA (2009) suggested the use of other terms, such as 'flood of a 1% probability of occurrence within a year' or 'flood with a probability of occurrence of 26% over 30 years' (the interval of 30 years is a standard repayment period of home mortgages in the US). Another form of communication

used today is a map of flood risk. However, studies show that each of these forms of uncertainty communication has both advantages and disadvantages.

- The term 'flood with a 1% probability of occurrence during one year' is probably the most straightforward and is understood better than other terms. It communicates uncertainty to a layman, but at the same time the audience tends to underestimate the probability of the phenomenon and does not undertake preventive actions.
- The term '100-year flood' makes non-experts believe that this is a flood that occurs exactly every hundred years (i.e., periodically) rather than once every hundred years on average, so it leads to underestimation of the likelihood of the phenomenon.
- The term 'flood with a probability of occurrence being 26% in 30 years' causes ordinary people to underestimate the probability of flooding. Furthermore, it is so difficult to understand that some researchers have suggested to stop using it as a means of communication (Bell & Tobin, 2007).

Thus, research shows that the communication of flood risk encounters many difficulties and can lead to serious misconceptions and misunderstanding. Therefore for the time being, descriptive messages are used in communication with non-specialists. The narrative includes the magnitude (small, medium or large) of the odds of flooding. It is not until later in the message that information about the likelihood of flooding is presented.

A solution used by the Environmental Agency in the UK (watermaps.environment-agency.gov.uk/) can serve as an example: flood risk maps for non-experts do not show the range of floods of different probabilities, but risk level expressed verbally: very low, low, medium, high (Figure 10.5). In further steps, the user gets information what should be done to reduce adverse flood effects.

Research shows that verbal expressions of probabilities are perceived as easier to understand and communicate than numerical probabilities (Budescu & Wallsten, 1985; Wallsten *et al.* 1993). People prefer to express risk in verbal rather than in numerical form (Brun & Teigen, 1988; Renooij & Witteman, 1999) and prefer to receive verbal rather than numerical probabilities (Erev & Cohen, 1990; Ohnishi *et al.* 2002). However, using exclusively verbal expressions can be misleading, because verbal labels are interpreted in a very ambiguous way (Brun & Teigen, 1988). Thus, some researchers suggest that verbal expressions should be used to support the numbers and assist in the evaluation of quantitative information in order to improve comprehension of the probabilistic character of the event (Burkell, 2004).

Another well-known psychological tendency is that when no flood disaster occurs for several years, people are subject to a so-called sampling error – they rely on the recent small sample and underweight the probabilities of a future flood, tending to ignore the small probabilities of a serious flood. (see Chapter 2 entitled 'Overweighting versus ignoring of small probabilities'). One can improve

the assessment of flood probabilities by presenting descriptive statistics based on a longer history of floods in the region. On the other hand, when a disaster has occurred recently, people tend to overweight the probability of its reoccurrence in the future. In such a situation, risk managers may try to lessen their sense of danger.

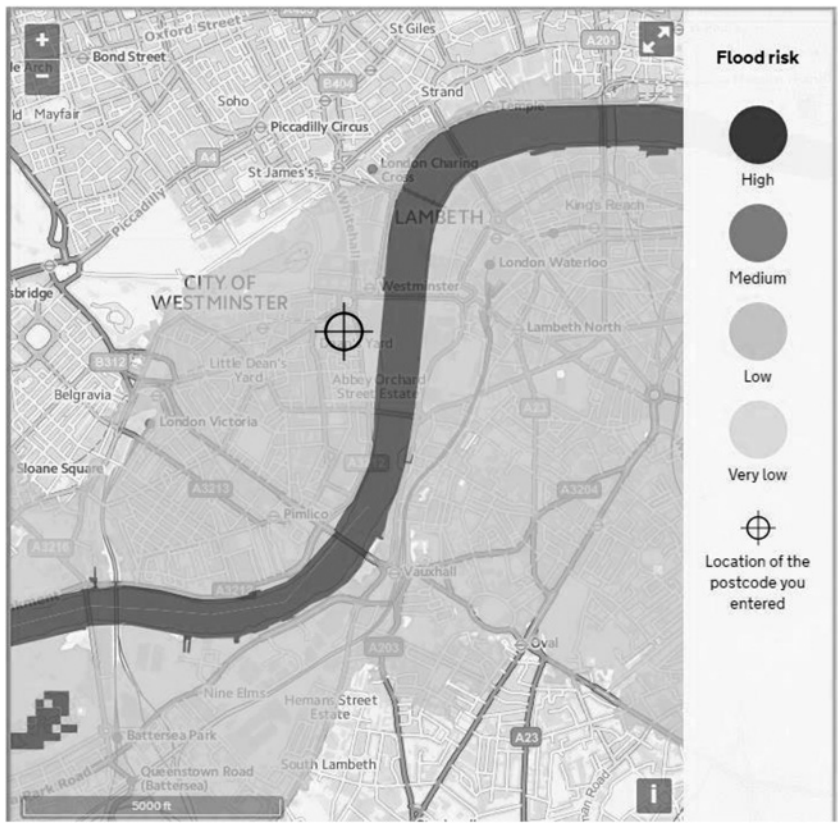

Figure 10.5 Flood map for city of London presenting, in a simple way, flood risk for selected point (Environmental Agency UK – https://www.gov.uk/check-flood-risk).

10.6 FACILITATING ACCESS TO IMPORTANT INFORMATION ON FLOOD RISK

Information is the basis of all action, and currently there is a lot of information available for people exposed to floods and other natural hazards. However, access to this information can be quite difficult. This section of the chapter deals with the

question of how to ease this access for people exposed to floods. Three topics are of particular importance:

- Improving the transfer of basic information;
- Providing people with guidebooks, brochures, and manuals addressed to vulnerable constituencies;
- Supporting social action and grassroots initiatives.

10.6.1 Improving the transfer of basic information

Access to various information materials and guidebooks on natural hazards, risk management, and prevention plans is becoming broader and better. This applies to hazard maps, risk management plans, and guidelines for the preparation of crisis management plans, for securing a home against flood, etc. Along with these are documents containing information on risk for particular areas, crisis management plans related to floods etc. This information is provided by the institutions that are responsible for flood risk management. Unfortunately, this information is not always easy to obtain. Furthermore, in some cases non-expert stakeholders are prevented from accessing such information.

Documents relevant to planning should be provided with so-called non-technical summaries about what can be found in them. The descriptions, of flood risk management plans in particular, despite claims that they are non-technical, are often written in technical jargon. And it is common for their actual content to have little to do with the descriptions of the content. Hence, the content of some documents described as non-technical flood risk management plans is illegible to non-experts. Other information such as the hydro-meteorological observations available on the Internet often lack keys that would facilitate their understanding and use.

In contrast, a good example of a document targeted at the public is the Flood Action Plan (Executive summary) for the area of the Somerset Levels and Moors prepared by the Environmental Agency in England (The Somerset … 2014). It is an attractive brochure with material written in simple language, richly illustrated, and available in versions for the blind (Braille alphabet) and for the elderly (printed in large font) and in an audio version and in different languages.

New technologies offer interesting possibilities. Applications for smartphones are becoming increasingly popular. A good example here is the 'Flood Warning App' for King County in the US (Flood warning App, 2014), which complements the local warning system and provides important flood-related education regarding simple ways to limit the effects of floods and information about the flood stage of the local rivers, updated every 10 minutes. The application uses data collected by various institutions and presents it in an attractive graphical form, making it easy for users to evaluate the situation and consequently to decide on appropriate actions.

10.6.2 Providing people with guidebooks, brochures, and manuals addressed to vulnerable constituencies

Basic information about potential flooding and descriptions of what can be done before, during, and after the event may be provided to stakeholders by guidebooks, brochures, manuals and so on.

These are useful for local governments and for residents. All flood risk management institutions should contribute to this effort, although it is advisable for one institution to play a coordinating role. The preparation of such guidebooks ensures access to basic, standardized information.

One can benefit from the experience of Australia, where the Australian Institute for Disaster Resilience (AIDR) (www.aidr.org.au) was launched in 2015 with the purpose of ensuring the coordination of the work of experts from many institutions, each having different responsibilities and competencies, such as the Australasian Fire and Emergency Services Authorities. The AIDR's functions include professional training related to various disasters and supporting in-school and volunteer training.

Another Australian institution – the Australian Emergency Management Agency – has extensive experience in publishing guides addressed to local governments, NGOs and threatened populations. Since 1986 it has issued over 40 extensive manuals in two series related to different types of disasters, covering a wide range of topics (e.g., Health Disaster, Flood Warning, Managing Exercises). Some of these publications have subsequently been updated and are available at no cost at the AIDR web portal (https://www.aidr.org.au/publications/manual-collection/).

Indeed, many countries in the world undertake similar publishing activities, albeit on a smaller scale, and it is worth paying attention to the content of such publications. They are typically fairly general guidance materials outlining what can and should be done. Less common are materials that tell also how to do it. An interesting example is the manual on constructing and securing facilities in flooded areas, prepared by FEMA in the US, called the 'Homeowner's Guide to Retrofitting. Six Ways to Protect Your Home from Flooding' (FEMA P-312, 2014).

Increasingly frequent are specialized handbooks targeted to selected groups of users of flood-prone areas. A very interesting document was published by the Environmental Agency in England and Wales (although it is an initiative of many institutions) for the owners of caravan and camping sites, of which there are around 1500 in England and Wales. This Handbook is entitled 'Flooding–minimizing the risk. Your caravan/camping site is in a flood risk area. Practical advice on keeping you and your visitors safe in a flood' (Flooding …, 2011). It informs the readership on how to make a flood plan covering key issues for such situations: how to improve communication with camping users before, during and after a flood, how to be sure that the right people are in the right place at the right time, how to protect the people, how to save time and resources, how to use the experiences of people from previous floods, and how to reduce loss and stress by helping people after the flood.

Recently, electronic flood simulation games are becoming increasingly common. For example, the German *SimFlood* on the role of flood insurance, the international (United Nations) *Stop Disasters* supporting the construction of communities resistant to disasters, or the English *FloodSim* (http://playgen.com/play/floodsim/) challenging its players to simulate the substantial task of creating flood control policy for the United Kingdom. Players must decide how much funds they allocate for flood protection, where houses can be built and where not, and what to do in order to inform the people. A survey, carried out in 2009 (Rebolledo-Mendez *et al.* 2009) among over 20,000 players demonstrates that the game does what it is supposed to, making users strongly committed to flood preparedness and significantly improving their awareness of flooding as a complex problem for which there are no simple solutions to reduce losses.

10.6.3 Supporting social action and grassroots initiatives

Endangered constituencies should be included in the process of independent flood and other natural hazard problem solving. This will involve several topics: problem identification, mutual assistance during a flood and after the flood, and consultation plans of a higher order, which is one of the most effective forms of education. It is practically the only opportunity for planners to have access to information about the actual process of flooding in the area, about the local causes of losses, and about the methods that can effectively reduce them. 'The people who live with flooding know as much, if not more, than scientists like me' said one professor at Oxford University who is a member of the Rydedale Flood Research Group (Joining forces …, 2014). Therefore, many countries support local action groups in various forms (e.g., UK, USA, Australia), in this way enhancing education and building teams to cooperate in the preparation of flood risk reduction plans. On the other hand, administrators at all levels, if such a process is not specifically demanded by regulations, treat public consultation as an obligatory evil and cumbersome formality.

In England, Wales and Scotland, national flooding forums were created along with local action groups in villages threatened by floods (http://www.scottishfloodforum.org/wp-content/uploads/2009/11/Guidelines-for-setting-up-Community-Flood-Groups-12.10.15.pdf). The tasks of these groups include coordination of the local community responses during floods, strengthening preparations in these communities for the next flood, and exploiting the assistance and expertise of others. Now in Scotland there are over 60 such groups, and the Scottish Flood Forum is preparing a special newsletter for them, providing them with knowledge and materials, and ensuring the participation of specialists in meetings with the residents.

In Australia (http://firefoxes.org.au/) after a huge bushfire in Victoria which killed 173 people, a group of women created an organization, the aim of which in the first phase was to deal with the trauma of the so-called Black Friday. It is now

one of the most active organizations in terms of training people in disaster-prone areas. These women share their experiences and knowledge with other communities regarding preparation, response, and reconstruction after fires and other disasters.

A similar initiative was undertaken in Poland after the 2010 flood by the Association of Residents of Bieruń and Cities Endangered by Flood located in the Upper Vistula Basin (Poland), ATLANTYDA, which was formed by the citizens who were themselves affected by the floods in 2010. This small group provides training to inhabitants and helps local governments to prepare for future events.

Another initiative of 70 residents from 31 households was established in Japan in a place where landslides and avalanches may occur during the rainy season. The Harunasan Disaster Preparedness Committee (Total disaster …, 2008) mobilizes every June, just before the rainy season. When a warning about the possibility of landslides is issued, cliff residents prepare to evacuate, and when notification of potential avalanches is sent, everyone evacuates to a designated location – the local museum. It is interesting that every house is equipped with a simple precipitation gauge, which is used to get every family in the habit of monitoring heavy rains that often cause avalanches around their houses.

10.7 INSTRUMENTS STRENGTHENING THE FLOOD-RELATED EDUCATION SYSTEM

Besides legal structures which address the obligations of specified institutions to undertake actions and engage in inter-institutional cooperation, it is necessary to develop effective mechanisms for motivating other stakeholders, independent of administrators, to undertake actions oriented towards the defined objectives. This applies, for example, to local training and educational activities.

One could envisage the creation of a system of grants for the creation of centers of flood-related education, whose task would be to promote actions at the local and individual levels, providing materials and expertise as well as undertaking training and educational activities addressed to residents and other groups of stakeholders. Grant proposals could relate to training for local governments, to information campaigns addressed to citizens, or to training of teachers.

A very simple and interesting way to support local activity is an Australian initiative to allocate yearly prizes for the most innovative activities protecting local communities from disasters. The purpose of this system of rewards – the Resilient Australia Awards (2016) – is to monitor the activities of various organizations and to support those that strengthen local communities and render them more resilient and better prepared for future risks. The initiative covers a wide range of activities in this field: risk assessment, research, training and education, information and knowledge management, prevention, preparation, response, and recovery. Prizes are allocated in the following categories: local communities, administration, business, schools, and journalism, and they are financed by the national government as well as the governments of individual states and territories.

A more sophisticated system of motivation for action was proposed several years ago by the American FEMA. It is a Community Rating System (FEMA, 2015) which encourages local communities to undertake long-term activities to increase effective responsiveness to flooding. It is addressed to local authorities which joined the National Flood Insurance Program, and it promotes taking actions in the following areas: improving communication and better informing the local community, improving the protection of new buildings in flood plains, reducing the risk for existing facilities, and enhancing flood preparation (e.g., improving warning systems, safety of structures such as dikes, etc.). The reward for these activities is the reduction of up to 50% of flood insurance premiums for private owners in areas whose local authorities earned the appropriate number of points for prevention.

Including all institutions and residents in the process of problem solving is of crucial importance. Supporting local activism leads to effective reduction of flood losses.

10.8 CONCLUSIONS

Floods and other natural disasters cannot be completely eliminated from our lives. One can only reduce the damage that they cause. Not only experts but also many other actors can contribute to flood risk reduction. They include central governments, local governments, and the endangered entities themselves. The goal of flood-related education is to improve the awareness of threatened entities of all issues related to flooding and enlist them in the process of preparation for a future flood. Three crucial aims of the flood-related education include:

- A broad recognition of the responsibility to protect one's own property and own safety by people at risk. This has important consequences; a broader range of knowledge to accomplish it is needed than is currently provided in educational materials, which focus attention almost exclusively on behavior during floods.
- Having access to information on local flood risks, to knowledge of the preventive methods to protect the property and possessions, to knowledge of the appropriate behavior before, during, and after a flood.
- Essential knowledge of the institutions that can help in different phases of risk management and in the reduction of all elements of the risk (hazard, exposure, and vulnerability). It is important to acknowledge that responsibility taking by people at risk does not imply exemption from action by other institutions for the benefit of those people at risk. The task of such institutions is to promote and support (through various avenues) the actions of endangered entities and to create conditions allowing individual actions to be successful.

Thus, flood-related education should describe the general characteristics of flood hazards, provide knowledge of local and global causes of floods, and – what

is most important – explain flood risk reduction measures. Educators should pay special attention to the problem of personal responsibility for safety (not only the state is responsible for it), of the illusion of safety (a mistaken sense of safety caused by the existence of technical means that reduce risk but do not eliminate it completely), and of effectively communicating risk (even when the public does not ask for an assessment of probability, it is worthwhile to give it to them because they can benefit from this information).

Currently there is a lot of information available to people exposed to flooding and other natural hazards. However, access to this information can be quite difficult. Of particular importance are: (1) how to improve the provision of basic information to vulnerable entities, (2) how to provide people with guidebooks, brochures, and manuals addressed to vulnerable entities, and (3) how to support spontaneous social activity by citizens in affected areas.

REFERENCES

Analiza obecnego systemu ochrony przeciwpowodziowej w Polsce (2013). Raport opracowany przez Zakład Gospodarki Wodnej i Systemów Wodnogospodarczych IMGW PIB, Krajowy Zarząd Gospodarki Wodnej, Warszawa. (Analysis of the present state of flood protection in Poland (2013). Report made by the Department of Water Management and Water Management Systems IMGW PIB, National Water Management Board, Warsaw.)

Bell H. M. and Tobin G. A. (2007). Efficient and effective? The 100-year flood in the communication and perception of flood risk. *Environmental Hazards*, **7**(4), 302–311.

Brun W. and Teigen K. H. (1988). Verbal probabilities: ambiguous, context-dependent, or both? *Organizational Behavior and Human Decision Processes*, **41**(3), 390–404.

Budescu D. V. and Wallsten T. S. (1985). Consistency in interpretation of probabilistic phrases. *Organizational Behavior and Human Decision Processes*, **36**(3), 391–405.

Burkell J. (2004). What are the chances? Evaluating risk and benefit information in consumer health materials. *Journal of the Medical Library Association*, **92**(2), 200.

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, Official Journal of the European Union (2007). Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0060&from=EN (accessed 11 August 2016).

Działek J., Biernacki W. and Bokwa A. (2013). Challenges to social capacity building in flood-affected areas of southern Poland. *Natural Hazards and Earth System Sciences*, **13**(10), 2555–2566.

Erev I. and Cohen B. L. (1990). Verbal versus numerical probabilities: efficiency, biases, and the preference paradox. *Organizational Behavior and Human Decision Processes*, **45**(1), 1–18.

FEMA (2009). Guide to Flood Maps. Using the Flood Map to Improve Your Understanding of Risk. Available at: water.ohiodnr.gov/portals/soilwater/pdf/floodplain/guide_to_floodmaps_Draft_Dec2009.pdf (accessed 11 August 2016).

FEMA (2016). High Water Mark Initiative. Available at: https://www.fema.gov/high-water-mark-initiative (accessed 11 August 2016).

FEMA B-573 (2015). National Flood Insurance Program. Community Rating System. A Local Official's Guide to Saving Lives Preventing Property Damage Reducing the Cost of Flood Insurance. Available at: www.fema.gov/media-library-data/1444398921661–5a1b30f0f8b60a79fb40cefcaf2bc290/2015_NFIP_Small_Brochure.pdf (accessed 17 August 2016).

FEMA P-312 (2014). Homeowner's Guide to Retrofitting. Six Ways to Protect Your Home from Flooding, Third Edition. Available at: http://www.fema.gov/media-library/assets/documents/480 (accessed 17 August 2016).

Flood Warning App (2014). King County, Washington, Available at: http://www.kingcounty.gov/services/environment/water-and-land/flooding/warning-system/app.aspx (accessed 17 August 2016).

Flooding–minimizing the risk (2011). Your caravan/camping site is in a flood risk area. Practical advice on keeping you and your visitors safe in a flood. Environment Agency, Bristol BS1 5AH, Available at: http://nationalfloodforum.org.uk/wp-content/uploads/FloodingMinimisingTheRisk_v2.pdf (accessed 17 August 2016).

Fordham M., Lovekamp W. E., Thomas D. S. and Phillips B. D. (2013). Understanding social vulnerability. *Social Vulnerability to Disasters*, **2**, 1–29.

Galloway G. E. (1999). Towards Sustainable Management of River Basins: Challenges for the 21st Century. Proc. RIBAMOD Meeting, Wallingford, UK, 25–27 February 1998.

IFMRC (Interagency Floodplain Management Review Committee) (1994). Sharing the Challenge: Floodplain Management into the 21st Century. A Blueprint for Change. IFMRC, Washington, DC, USA.

Joining forces against flooding (2014). University of Oxford. Available at: https://www.socsci.ox.ac.uk/research/casestudies/joining-forces-against-flooding (accessed 17 August 2016).

Konieczny R., Rataj C. and Siudak M. (1999). Badanie percepcji zjawisk powodziowych przez mieszkańców na terenach zalewowych, Instytut Psychologii Polskiej Akademii Nauk i Instytut Meteorologii i Gospodarki Wodnej Oddział w Krakowie, raport wewnętrzny. (How inhabitants in floodplain areas perceive the flood, Institute of Psychology of the Polish Academy of Sciences and Institute of Meteorology and Water Management, Krakow Office, internal report.)

Konieczny R., Działek J., Siudak M. and Biernacki W. (2016). Działania właścicieli domów dla ograniczenia skutków powodzi oraz ich motywacje, w: 'Problemy planowania w gospodarce wodnej i oceny stanu hydromorfologicznego rzek', Monografie Instytutu Meteorologii i Gospodarki Wodnej PIB, IMGW Warszawa. (Activities of homeowners to reduce the effects of flood and their motivations, in: 'Problems of planning in water management and assessment of hydromorphological condition of rivers', Monographs of Institute of Meteorology and Water Management PIB, IMGW Warsaw) (in press).

Kreibich H., Thieken A. H., Petrow T., Müller M. and Merz B. (2005). Flood loss reduction of private households due to building precautionary measures—lessons learned from the Elbe flood in August 2002. *Natural Hazards and Earth System Science*, **5**(1), 117–126.

Kuhlicke, Ch., Steinfuhrer A., Begg, Ch., Bianchizza, Ch., Brundl M., Buchecker M., De Marchi B., Di Masso Tarditti M., Höppner C., Komac B., Lemkow L., Luther J., McCarthy S., Pellizzoni L., Renn O., Scolobig A., Supramaniam M., Tapsell S., Wachinger G., Walker G., Whittle R., Zorn M. and Faulkner H. (2011). Perspectives on social capacity building for natural hazards: outlining an emerging field of research and practice in Europe. *Environmental Science & Policy*, **14**(7), 804–814.

Kundzewicz Z. W. (1999). Flood protection – sustainability issues. *Hydrological Sciences Journal*, **44**(4), 559–571.

Learning lessons from the 2007 floods. An Independent Review by Michael Pitt (2008), Cabinet Office, Available at: http://webarchive.nationalarchives.gov.uk/20100807034701/http:/archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html (accessed 11 August 2016).

Mercer J., Kelman I., Lloyd K. and Suchet-Pearson S. (2008). Reflections on use of participatory research for disaster risk reduction. *Area*, **40**(2), 172–183.

National Research Council (NRC) (2000). Risk Analysis and Uncertainty in Flood Damage Reduction Studies. National Academy Press, Washington, DC.

Ohnishi M., Fukui T., Matsui K., Hira K., Shinozuka M., Ezaki H. and Shimbo T. (2002). Interpretation of and preference for probability expressions among Japanese patients and physicians. *Family Practice*, **19**(1), 7–11.

Podraza U. (2003). Współpraca z mediami. Poradnik, Instytut Meteorologii i Gospodarki Wodnej, Warszawa. (Cooperation with the media. Handbook, Institute of Meteorology and Water Management, Warsaw.)

Rebolledo-Mendez G., Avramides K., de Freitas S. and Memarzia K. (2009, August). Societal Impact of a Serious Game on Raising Public Awareness: The Case of FloodSim. Proceedings of the 2009 ACM SIGGRAPH Symposium on Video Games (pp. 15–22). ACM.

Renooij S. and Witteman C. (1999). Talking probabilities: Communicating probabilistic information with words and numbers. *International Journal of Approximate Reasoning*, **22**(3), 169–194.

Resilient Australia Awards (2016). On the portal of Australian Government. Attorney-General's Department. Available at: https://www.ag.gov.au/EmergencyManagement/About-us-emergency-management/Resilient-Australia-awards/Pages/default.aspx (accessed 17 August 2016).

SEPA (n.d.) Responsibilities for flooding, Available at: http://www.sepa.org.uk/environment/water/flooding/responsibilities-for-flooding (accessed 11 August 2016).

The Somerset Levels and Moors Flood Action Plan (2014). Executive summary. 'We cannot let this happen again'. Prime Minister, David Cameron, 13th February 2014.

Tobin G. A. (1995). The levee love affair: a stormy relationship. *Water Resources Bulletin*, **31**(3), 359–367.

Total disaster risk management: Good practices (2008). Asian Disaster Reduction Center. Available at: http://www.preventionweb.net/files/9052_TDRM08.pdf (accessed 17 August 2016).

Wallsten T. S., Budescu D. V. and Zwick R. (1993). Comparing the calibration and coherence of numerical and verbal probability judgments. *Management Science*, **39**(2), 176–190.