

## Flood risk perception and implications for flood risk management in the Netherlands

PAUL J.A. BAAN\* AND FRANS KLIJN, WL | Delft Hydraulics ([www.wldelft.nl](http://www.wldelft.nl)), PO Box 177, NL-2600 MH Delft, The Netherlands

\*Corresponding author. Tel.: +31 15 285 8409; E-mail: [paul.baan@wldelft.nl](mailto:paul.baan@wldelft.nl)

### ABSTRACT

A society well-aware of risks must not only give attention to the prevention of flood risks but must also consider disaster management, i.e. minimising casualties and flood damages, and enhancing recovery. The Netherlands has a solid network of levees along the rivers that protect the many low-lying polders from flooding. But nature is unpredictable, extreme events may happen, and absolute protection against flooding cannot be offered.

It is common practice to perform technical and economic analyses to determine the feasibility of flood protection plans. And usually also institutional and administrative aspects are addressed. But how the people that live in the polders feel about flood risk and protection plans seldom gets due attention. This paper primarily looks into the attitude of the people. How do people live with (flood) risks and how do they feel about that? What can be learned from that for communication on flood risks and flood risk management? Finally, we give some recommendations about what elements to consider when developing a flood risk management strategy.

*Keywords:* Flood risk; risk perception; flood management.

### Introduction

The level of flood protection along rivers in the Netherlands is among the highest in the world. According to the Dutch Law on flood protection, dikes along the main rivers must all be built for a 1/1250 year design flood. This uniform high level of protection has been realised in the last decades by reinforcing the hundreds of kilometres of levees along the rivers. This way of protecting polders from flooding seems to have been effective: the last river flood causing dike breach and flooding several polders occurred in 1926 as a result of the highest Rhine discharge ever recorded with about 12.600 m<sup>3</sup>/s. In 1993 and 1995 again huge floods occurred, although the discharge remained well below that of 1926. Still, in 1995 the polders along the Rhine River experienced a narrow escape from being flooded. Since then, the gradually neglected levees have been heightened and strengthened at full speed (Silva *et al.*, 2004).

The 1993 and 1995 floods raised flood risk awareness again. At the same time, the debate about the – primarily technical – flood protection philosophy in the Netherlands was resumed (cf. Vis *et al.*, 2003; Klijn *et al.*, 2004). Of course, the Dutch can cope with the increasing frequencies and levels of floods due to climate change by heightening and strengthening the levees. But with flood levels in the rivers going up and the population and economy in the low-lying polders growing at a steady pace, a dike breach may turn into a disaster. A change in protection philosophy can already be observed as, firstly, the government

adopted a *room-for-the-river* policy aimed at lowering flood levels by giving more room to the rivers instead of heightening dikes and let the flood levels go up, and as, secondly, the government now seriously considers the purposeful inundation of so-called ‘calamity polders’ in order to protect downstream polders from accidental flooding.

The 1993 and 1995 floods made many people feel uneasy, but the present planning of room-for-the-river measures and calamity polders provokes real commotion among the people involved. People living in the would-be calamity polders, for example, are very worried about the plans and protest. And although it is common practice to perform technical and economic analyses to determine the feasibility of measures, and whilst also institutional and administrative aspects are often taken into account, the question of how the people involved feel about the plans gets only little attention. Therefore, this paper discusses some psychological aspects which are relevant for practical flood risk management and risk communication. It addresses questions such as how people – especially in the Netherlands – feel about living along rivers, whether they are concerned about flood risk at all, and how do they expect a flood will affect their lives. We address these issues, as flood risk management for a modern society requires that social and psychological issues are seriously taken into account in decision making. Based on the discussion, elements are identified that should be considered in the further development of a flood risk management strategy for the Netherlands.

Intentionally, we focus on the present situation in the Netherlands and put the findings in context by referring to relatively recent literature only. We do, however, recognize that research on risk perception and assessment already started about 40 years ago (e.g. Starr, 1969) and that since then many publications have appeared from various scientific points of view: psychological and sociological (e.g. Drabek, 1986; Quarantelli, 1989), anthropological and cultural (e.g. Dynes, 1998), political and juridical (e.g. Rehman-Sutter, 1998), and of course also technical. But it is not our intention to give a historic overview of this research.

### Living with flood risks: casuistry

#### *Living with dormant flood risk*

Presently, people living in polders along rivers in the Netherlands do worry little about the risk of flooding. Environmental psychologists explain this by what they call 'the crisis effect' and 'the levee effect'.

The crises effect indicates that disaster awareness peaks during and immediately after its occurrence, but rapidly dissipates between disasters (Stefanovic, 2003). People are short of memory. Immediately after a (near) flood people overestimate flood risk. After some time worries decrease, and after some years flood risk is again grossly underestimated (Penning-Rowsell, 2003).

The levee effect refers to the fact that once protection measures have been taken, people place unrestrained and often inappropriate faith in the power of the protection works. People seem to be lulled into thinking the levee will protect them against all future floods (Stefanovic, 2003) and live light-heartedly behind the levees.

Because of these two effects, people living in the polders along Rhine and Meuse in the Netherlands do not feel the need to anticipate a possible flood and are ill-prepared. Moreover, despite of – or should we say: because of – the fact that these people have no experience with flooding, they very much fear the consequences of a possible flood. People living in the floodplains are, in contrast, more familiar with flooding, better prepared, and feel much less threatened (Baan and Klijn, 2003).

#### *Living with immediate flood threat*

During a peak discharge, the high dikes along the rivers cause the water level to rise several meters above the level of the polders and – in 1995 – to less than 0.5 m below the top of the dike. For many people living in these polders, these high water levels and the extent of the river in flood form a frightening sight (Photo 1). The few hundred people living in the floodplains are used to the dynamics of the river and feel less frightened than the many hundreds of thousands of people living in the polders. In the polders, people know very little of the behaviour of the water, the probability and development of a breach, the speed of the inundation process and the possible and final flooding depths. In 1995 it appeared that the local administrators knew little of these



Photo 1 Flood levels meters above land levels are frightening to many. Directorate-General for Public Works and Water Management, the Netherlands.

facts either, and had cities evacuated which would have suffered only 30 cm of water depth at the maximum.

People often find evacuation more troublesome and threatening than the high water levels in the river (De Vlieger *et al.*, 1998). People new to the area are less familiar with high water levels and often feel more stressed than autochthons during a flood. The autochthons have knowledge of the river's behaviour and have developed skills to cope with the situation of high water levels, in other words; they are not only technically better prepared, but also psychologically better prepared. Experiences with high river water levels and evacuation turn flood risks into something imaginable and less threatening (Slootweg and Van Schooten, 2002).

Some groups of people depend on the care of others, and as a result are more vulnerable: elderly people, ill and disabled people, and people who live in isolated places. These vulnerable groups often find flood risks more threatening. And in case of preventive evacuation these people need special attention (Slootweg and Van Schooten, 2002).

Feelings of inconvenience and stress may already start when extreme levels are forecast and the water level in the river starts to rise. When evacuation is needed the feelings of stress aggravate. A long prolongation of the evacuation further increases the

feelings of stress. The attitude of people to the stress and the feelings of inconvenience caused by the high water levels differ strongly between individuals. Some people remain easy-going while others feel very threatened indeed (Baan and Rabou, 2002).

Not all feelings are negative. People in a flood-threatened polder experience togetherness and solidarity, which they qualify as being positive feelings. The social coherence and the relationships between inhabitants improve during an immediate flood threat. Some people even consider a flood as exciting and like its mild danger (Baan and Rabou, 2002). Gratitude for mutual help is also mentioned as being a positive effect of a flood with a narrow escape from an actual dike breach-like the 1995 flood (Slootweg and Van Schooten, 2002).

People, who are well-prepared and who know how to act adequately during and after a flood, feel less threatened and can be considered less vulnerable from a psychological point of view. In the eyes of such people the situation remains manageable to some degree, also yielding the communities they are part of less vulnerable from a socio-economic point of view (Baan and Klijn, 2003). Proof that experience with flooding and resultant improved preparedness do affect vulnerability comes from Germany, for example, where it was found that the economic losses during the 1995 flood were only half those from the 1993 flood, although the two events were of comparable size (Kron and Thumerer, 2002).

The threat of flooding decreases when it is certain that flood damage will be compensated for. It turns out that people who are well-insured cope better with the threat of losses. People who have to ask the government for financial assistance after a disaster feel stressed, dependent and inferior (Valk *et al.*, 2003). Moreover, in the Netherlands, the average citizen finds it unfair to bear the consequences of events that are neither his or her fault nor the result of his or her actions (RVZ, 2001).

#### *Living with accidental (uncontrolled) floods*

Natural river valleys have river banks gradually sloping upwards. In case of flooding water depth remains restricted to often less than 1 meter, whereas in low-lying polders behind levees water depths may reach several meters causing serious danger of drowning. Still, knowledge about how people in developed countries experience a real flood can only be gathered from natural valleys, as polders are being flooded too seldom. We refer to experiences with Meuse River floods in the Netherlands and with the 1998 floods in the UK.

In 1993 and 1995 the river banks of the upstream part of the Meuse River were flooded. But this upstream part is a natural valley. De Vlieger *et al.* (1998) found that, as their life is not endangered, people living on these banks generally don't feel unsafe. Before the 1993 flood most of the people were, in fact, not consciously aware of any flood risk. After the flood the majority of the people felt tensed and ill and one third of the people were not able to go to work for some time. One quarter of the people who felt ill needed more than five weeks to recover. However, most of the people living along the Meuse were found to be strongly attached to their resident area and would not consider

moving despite their experience with flooding (Slootweg and Van Schooten, 2002). Low expectations of selling prices of houses after the flood played a role too.

The health effects which can result from a flood are often very marked ranging from premature death to general feelings of ill-health (Tapsell *et al.*, 1999). Hazards such as floods can be regarded as potentially multi-strike stressors. Apart from the disruption to households by the flood event itself, the effort needed to recover after the flood can also affect people's health. In the 1998 floods in the UK, the main impacts of recovery disruption were found to result from: having to leave home; lack of practical and emotional support; lack of advice on what to do; problems in dealing with insurers and builders; stress from living in damp and damaged properties; and increased financial worries (Tapsell *et al.*, 1999).

The loss of memorabilia and sentimental possessions often causes acute distress to many flood victims. This loss may undermine people's sense of self identity and place identity. People develop a sense of self, based on where they live. The home is often conceived as an emotional sanctuary and haven from the outside world. This home, which may have taken years to create in a personal style, must be redecorated and refurnished in weeks or months and the choice of furniture and decoration is then often based on a fear of future flooding rather than on preferred style. Some flood victims described a sense of violation and invasion in the home, which was no longer a secure place to live (Tapsell *et al.*, 1999). Women appeared to suffer more from the disruption to the home, as they have to deal with the recovery from the flood most directly, in addition to bearing the main responsibility for their family's health care (Tapsell *et al.*, 1999).

After the repairs have been completed and the painful memories have been faded away, the tension relieves again, and people can resume living their normal lives.

#### **Some general risk concepts**

Human activities, natural hazards, and combinations of both all involve risks. Risk is an integral part of human life. We do not and cannot live in a risk-free society; the taking of risks can even be regarded to have been the engine of many economic and social developments (Rees, 2002).

Still, especially in the developed countries technological developments helped to lower the overall risk level in the last century, as evidenced by a much longer life expectancy. Here the remaining risks, however, get a lot of attention, partly caused by the societal and normative changes related to modern society.

#### *Technical risk analysis versus a psychological perspective*

In technocratic circles, risk is generally defined as the probability that an unwanted event occurs times the consequences (casualties and damage) of that event. This allows that risks be compared to each other based on either the probability alone – in case of

Technical rationale		Cultural rationale
trust in scientific methods, evidence and explanations	↔	trust in political culture and democratic process
appeal to authority and expertise	↔	appeal to folk wisdom, peer groups and cultural tradition
boundaries of analysis are narrow and reductionist	↔	boundaries of analysis are broad and include use of analogy and historical precedent
risk is depersonalised focusing on measures of statistical variation and probability	↔	risk is personalised with emphasis on impacts on the community, and family
concerns and issues that can't be described or clearly expressed are irrelevant	↔	unanticipated or unarticulated issues or concerns are relevant

Figure 1 Technical versus cultural rationality in viewing risks. *Source:* Barnes (2002).

equal consequences – or on the product of probability and effect. Also, it allows that cost effectiveness analyses (how much risk reduction can be realised with a certain budget) be performed, which may reveal whether (tax) money is spent well or wrongly (RIVM, 2003). Such risk trade-offs, however, do generally not address the basic opportunity cost problem, which also involves that you may consider spending the same amount of money on other welfare issues. Then, the key question is where priorities should lie; is it – from a social welfare point of view – better to invest in reducing flood risk, or in improving public health, water security, food security or in reducing risks of environmental degradation? (Rees, 2002).

In contrast to technocrats, lay-people take many more aspects into account when individually judging risks than the results of cost effectiveness analyses alone. Qualitative aspects, like the (perceived) degree of free choice, equity, degree of control of the risk, but also gains that are expected, are often decisive for risk acceptance (RIVM, 2003). And people also base their judgement on preferences. When people like an activity, they underestimate the risk and overestimate the possible gains, and the other way around (Slovic *et al.*, 2002).

So, obviously there are large differences between how the government and experts view risks and how the public at large views risks. In evaluations, government and experts apply an analytical approach while the judgement of the public is rather based on experiences and feeling. The analytical approach uses algorithms, for example to calculate probabilities, and formal logics to determine risks in relation to pre-set quantitative standards. The public reacts more emotionally based on earlier experiences, and judges on the basis of qualitative aspects and feelings (Slovic *et al.*, 2002; Flinterman *et al.*, 2003; Slovic and Weber, 2002). These 'different rationalities' are considered to be one of prime reasons why the public and experts disagree on risk issues (cf. Margolis, 1996). Although, of course, flood risk experts cannot be considered to be entirely neutral, disinterested protectors of the public good either, as their opinions are coloured by their strive to maintain jobs, budgets or research grants, or the aggrandisement of bureaucracies (cf. Rees, 2002).

Slovic *et al.* (2002) state that an analytical approach of risks can only be effective, when it is guided by emotion and feelings: 'the dance of affect and reason'. People base their judgement not only on what they think about it, but also on what they feel. Thus, feelings have a direct effect on the judgement of risks. According to Slovic *et al.* (2002) scientific research on the mutual influence of rationality and feelings is still in its infancy.

Figure 1 shows the main differences between how government and experts view risk on the one hand (the technical rationale) and how the public perceives risk on the other hand (the cultural rationale).

#### *Risk perception and acceptance: the psychological perspective*

The perception and acceptance of risks depends on the socio-cultural context, the characteristics of a risk (e.g. man-made or a natural hazard), the degree of freedom of exposure, the degree of control of hazard and its consequences, and the question how much personal advantage is at stake. Figure 2 presents a schematic overview of the individual cognition of risks and the resulting risk behaviour.

Many researchers have been involved in determining the factors ('dimensions') of risk that can explain differences in individual risk perception and acceptance. The number of factors identified varies from a few important ones to long lists. Sjöberg and Drottz-Sjöberg (1994) drafted a more or less complete list of 27 factors, of which 10 are related to the character of the risk, 11 to the social context, and 6 to personality. Personality is important to understand individual risk perception, but is difficult to take into consideration in risk assessment and preventive management; for instance, females judge risks usually more severe than male (Weber *et al.*, 2002). The understanding of individual risk perception is far from complete. Currently, all factors together explain less than 50% of the variance between individual risk perceptions (Sjöberg, 2000).

Lyklema (2001) tried to identify the key factors for water related risks in the Netherlands. The following factors were found

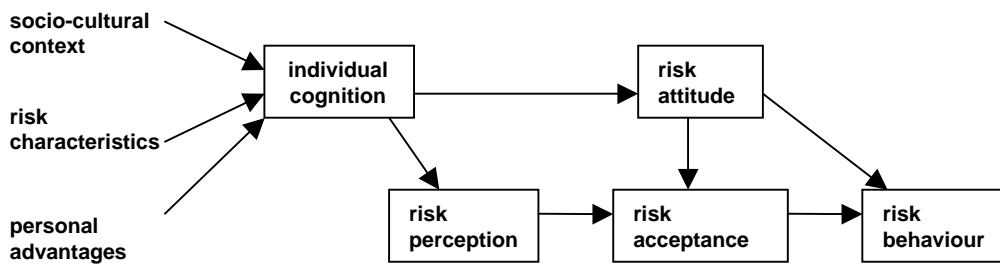


Figure 2 Scheme of individual cognition of risks and resulting risk behaviour. Adapted after Flinterman *et al.* (2003).

to be most significant for the people’s judgement:

- the fairness of the division of risks and gains between parties involved;
- the familiarity with the risk and the effects to people exposed;
- the reasons of the exposure to the risk;
- the seriousness of the effects;
- the degree of preparedness and the degree of control of consequences.

Vlek (2001) emphasises the importance of this last factor when stating that the perceived control is a key factor for understanding the perception, attitude and behaviour of people in risk situations.

*The role of the media*

Media and social processes are known to influence the perception and acceptance of risks. When the media are the only source of information for the public, the effect on risk perception may be decisive. Media can contribute to what is called ‘social amplification of risk’ (e.g. Slovic and Weber, 2002). Social amplification implies that the direct impacts of an event need not be large but can still trigger major indirect impacts. A small incident in an unfamiliar system (or one perceived as poorly understood) may have immense social consequences if it is perceived as an omen of future catastrophic mishaps. Media jump on such incidents as such events are ‘hot news’. As a result efforts and expenses might be warranted to reduce the possibility of ‘hot-news events’ far beyond what is justified by a cost-benefit analysis (Slovic and Weber, 2002; RIVM, 2003).

Strong social networks influence individual perceptions. Members of such networks who maintain close interpersonal contacts are likely to share similar information, attitudes, beliefs, and

behaviour on controversial topics. Analysis by Scherer and Cho (2003) confirmed that social linkages in communities may play an important role in focusing risk perceptions. Such a collective attitude may result in the formation of a ‘socio-psychological shield’, which prevents information to come through. In front of strong social networks attempts of government and experts to change attitudes, beliefs and behaviour may have little or no effect.

**Back to flood risks**

The issues discussed above also hold for flood risks, or contain important lessons for flood risk management and communication about it. Here we shall, firstly, investigate how flood risk relates to other risks from the psychological point of view. Secondly, we go into communication about flood risks. Next, we discuss how purposeful inundation – as a measure to gain control over floods – may be perceived by the public. And finally, we discuss some dilemmas met in further developing a flood risk management strategy for the Netherlands, including a differentiation of protection levels and purposeful inundations.

*Flood risks and some other risks compared*

In Table 1 the authors judged the risk factors of Lyklema (2001) for a variety of well-known risks. Though the scoring is subjective and the uncertainty margins are relatively wide, rather certain conclusions may be drawn.

The risk of a disaster with a nuclear power plant is judged as most threatening, despite its low probability. Scores for flooding are also rather high. Both represent involuntary risks without clear individual gains, but with potentially large numbers of casualties. Purposeful inundation is considered more threatening than accidental (uncontrolled) flooding.

Table 1 Scores of five different risks on risk factors of Lyklema on a scale of 0 (unimportant) to 4 (very important or serious)

Risk factor	Smoking	Bee sting	Nuclear power plant	Road traffic	Flood <sup>1</sup>
<i>Probability of casualty</i>	10 <sup>-3</sup>	2 × 10 <sup>-7</sup>	10 <sup>-7</sup>	10 <sup>-4</sup>	10 <sup>-7</sup>
Fairness of division of losses and gains between parties	0	1	4	1	1 (4)
Familiarity with risk and effects	0	1	3	1	2
Reasons of exposure to risk	0	1	3	0	2
Seriousness of effects	1	1	4	2	3
Degree of preparedness and of control of consequences	2	1	3	1	2
Percentage of maximum score	15%	25%	85%	25%	50% (65%)

<sup>1</sup>When scores for inundation differ from those assigned to (uncontrolled) flooding the scores are presented between brackets.

Risks of smoking and road traffic are clearly judged as less threatening than the risks of a nuclear power plant or a flood. Smoking and participating in road traffic are voluntary activities with obvious individual gains. Moreover, the impacts are mostly small-scale, involving small numbers of people per incident. The risk of death through a bee sting is considered a natural and small risk.

#### *On communication about flood risks*

The rareness and unpredictability of floods, as well as their potentially huge impacts put great demands on communication. It is known that people deal with information in a selective way; they absorb only what is relevant and convenient to them and as long as it fits in with their idea of reality. This means that people, when threatened with a flood, will not always react as government expects or would like to. For instance, it is difficult to have everybody evacuated in time from an area threatened by flooding (Slootweg and Van Schooten, 2002).

People wish information in a language *intelligible* to them and also want their feelings to be taken into account. It is known that people understand *percentages* of probability better than frequencies (Slovic *et al.*, 2002). And also, expressing impacts in *positive* terms (number of survivors) may be less threatening to people than expressing them in negative terms (number of casualties). Similarly, a (negative) flood probability could be expressed as a (positive) protection level.

This would mean, for example, that flood risks which are currently expressed as frequencies, e.g. as a '500 years event' or as 'once in every 500 years flood' could alternatively be presented as a protection level of 99.8% a year. Psychologically, this way of expressing risks has even more advantages than being better understood. It makes clear that: (a) the protection level is less than 100%, implying that floods may happen; and (b) that the protection level can be improved only a little bit by often very expensive measures.

Moreover, in communicating, government must be clear on *uncertainties*, as Stefanovic (2003) states: 'sounding more certain than the data can justify is a sure way to lose trust and credibility.'

So far, we discussed one-directional communication, which is of course necessary in many cases and in fact the only option during an immediate flood threat. In the process of developing a flood risk management strategy or when designing individual measures which may affect many people's lives, however, one-directional communication from government to public only is bound to fail. With experiments on participative decision making, Arvai (2003) demonstrated that involving people in the analytical and decision making process contributes to gaining a sound social basis. It was found essential that people and parties should be involved in an early stage in the decision making process on risk management and the communication about it. This allows people to understand the problems, to co-analyse possible solutions, and to participate in drawing conclusions.

#### *On the perception of purposeful inundations*

People find man-induced disasters more threatening than natural disasters. Man-induced disasters also remain longer in the people's collective memory (Valk *et al.*, 2003). Presently, half the people living along the Netherlands' rivers think that floods have natural causes. The other half believes that floods are caused by man (De Vlieger, 1998).

But what if authorities consider inundating calamity polders on purpose to protect more downstream areas? Then, obviously the flooding is completely human-induced. This is bound to affect the perception and acceptance by the people living in the very calamity polder:

- they may find the flood compulsory;
- they may consider the division of losses and gains unfair;
- they may doubt the beneficial effects on society at-large;
- they may develop mistrust of government and experts.

These local perceptions may enlarge the society's overall fear for floods. Moreover, a decision to begin inundation will probably get a lot of attention in the media. Altogether people living in calamity polders will be likely to consider a purposeful inundation more disquieting than an uncontrolled flood. This might be detrimental to its acceptance.

The frequency that a calamity polder will be flooded will be higher than the frequency that other polders will be flooded. Starting the discussion on the possibility of assigning calamity polders in the Netherlands some years ago already got people in the very polders worked up; feelings ran high and still run high. It generates feelings of suspicion, uneasiness and fear among the people. These feelings aggravate when people believe that the assignment is not being evaluated carefully enough and think that not all alternatives have been taken into account seriously enough. People also get upset when it is not clear to them what 'the country' will do in return for the sacrifice they make (Baan and Rabou, 2002).

Assigning a calamity polder may start social and economic processes that influence the regional development of the area. Some people will move away from the polder because of the risk and the expected changes to the landscape. The inhabitants fear social disruption to the usually rural and very coherent village communities. Especially the autochthonous population dislike that and consider the social disruption as the greatest loss (Van der Werff, 2000). People also fear a drop of the value of property, and retardation of economic development due to a lower willingness to invest in the area. Finally, they are afraid that the uniqueness and the splendour of the landscape may be spoiled by high dikes and civil construction works (Slootweg and Van Schooten, 2002).

Fact is that an actual inundation of a calamity polder will cause damages, both tangible and intangible. People must be evacuated for weeks and fear the nuisance, the tension and the social disruption, when this might happen. People also fear environmental effects due to (polluted) sediments settling in the polder and through emissions induced by the flooding (Baan and Rabou, 2002).

Obviously, the people have a tendency to magnify the negative effects and to lose sight of possible positive effects. But it

is uncertain how a calamity polder will develop in reality after having been assigned. In view of the current flood protection policy, the probability that a calamity polder along the Netherlands's rivers would be flooded is about 1/1250 per year. With such low probabilities government expects that the current rate of spatial and economic development will be maintained. But how the citizens and businesses will really behave in future also depends on their perception of the consequences of being assigned a calamity polder.

As flooding of calamity polders is done on purpose, it is generally reckoned that the flood damage must be compensated for. Currently, the people's experience with damage compensation is bad. Many (Baan and Rabou, 2002; Slootweg and Van Schooten, 2002; Baan, 2003) state that purposeful inundation requires generous settlement of damages. Not only economic damage should be compensated for, but also the inconvenience caused by the flooding and the impacts it has on the rural communities should be taken into account. This may contribute to gaining social support for the assignment of calamity polders.

### Development of a flood risk management strategy

The flood protection level along the main rivers in the Netherlands is very high. It relies completely on preventing floods by structural measures which offer a uniform protection level against a design discharge of 1/1250 per year. Non-structural measures aimed at vulnerability reduction (land zoning, changing flood plain cropping patterns, and building design) or loss pooling schemes (insurance) get hardly any attention.

In a comprehensive flood risk management strategy both structural and non-structural measures should be used (Hooijer *et al.*, 2002, 2004). Such a strategy should aim at making communities less vulnerable to floods and should be preferably anticipative and not responsive (Stefanovic, 2003). To be able to design such a strategy, we must understand how the physical and societal systems work, what the causes are of the (increasing) risks, and how we can manage the developments. We do not want to shift off problems and losses to future generations; we want to get rid of problems and to eliminate losses. We also have to realise that the answers we get, depend on the questions we put (Stefanovic, 2003). Our paradigms, attitudes and beliefs have influence on: (i) the scientific questions we put; (ii) the choices we make related to the approach and methods to search for solutions; and (iii) how we interpret and analyse the data and results of analyses. Sustainable solutions can be found only when qualitative research on human values and perceptions – and on how to change these – is part of the investigations.

Important questions and choices in the quest for a further development of a sustainable flood risk management strategy for the Netherlands include:

- Is uncontrolled flooding still acceptable from a societal point of view or should we prevent that by all means and gain control over the flooding process?

- How much flood damage is acceptable in polders; and how will government ensure that this maximum level of damage is not exceeded?
- Is it acceptable that protection levels differ between polders and which protection levels are preferable in view of the potential flood damage?
- Is the desired protection level realised by structural measures only or also by non-structural and emergency measures?
- To what extent can the government count on the ability of inhabitants and businesses to take an own responsibility in coping with floods?
- Will government compensate victims for flood damage suffered and/or must it be made possible to insure flood damages? And what demands can insurers put on citizens and businesses?
- What will be the base for determining damage compensation in case of inundation? Are intangible effects included and to what extent?

### Uncontrolled flooding or inundation

When purposeful and controlled inundation is preferred to uncontrolled flooding resulting from dike breach, an order of flooding must be determined in advance. The location on the river and the potential flood damage are decisive for determining which polder to inundate first, second, etc. Thus, the order is decided not only by potential flood damage, but also by location along the river (upstream), as the purposeful inundation is intended to lower the water level in the river.

With the present equal protection levels, all polders along the river may be flooded equally frequently. Or rather, it cannot be known in advance when and where flooding will happen – although it is most likely that the most upstream polders along a river will be hit first. When the location of a breach is not known, the flood damage can be much larger than with purposeful inundation, as vulnerable polders are not spared (Vis *et al.*, 2003). And when the inflow is not controlled but scouring a breach, water levels in the polders may become very deep, and flood damage unnecessary high (Dijkman *et al.*, 2003). Against this background, we maintain that along rivers uncontrolled flooding should be over and done with. Society and politics should aim at decreasing potential flood damage. In case of immediate flooding threats, authorities should decide to inundate the least vulnerable polders in order to spare the more vulnerable ones. In countries like France (Anonymous, 1998), Hungary, Italy and the US this is already common practice (cf. Dijkman *et al.*, 2003).

### Acceptable flood damage

Measures to protect polders from flooding are expensive. Their costs increase non-linearly with the level of protection. Hence, a compromise must be found between the costs of construction and expected losses due to flooding (Kron and Thumerer, 1999). It has been stated recurrently that reducing the flood damage potential is by far the most cost-effective measure (cf. Hooijer *et al.*, 2002). There are many possibilities to reduce the potential flood damage: (i) spatial planning to slow down economic

developments in vulnerable polders; (ii) the construction of secondary levees within a polder to decrease the area which will be flooded; (iii) adapted building constructions and flood-proof decoration and furnishing.

A cost-benefit analysis may reveal which measures aimed at reducing flood damages are economically feasible, e.g. compartmentalisation by splitting up polders through extra levees (Vis *et al.*, 2003; Klijn *et al.*, 2004). Apart from the balance between sheer financial costs and benefits there may be other reasons to take measures which reduce the flood damage. Taking into account intangible effects, such as psychological impacts and damage to natural and cultural heritage, may turn the scales in favour of taking measures.

Nowadays, a new or adapted flood risk management strategy should contribute to sustainable development, which means taking into account the possibilities and interests of future generations. In this context, new concepts and objectives are being formulated, such as to increase a flood risk management system's resilience (De Bruijn, 2004) or to maintain sufficient flexibility in order to allow future generations to respond on yet unforeseeable developments and normative views (Klijn *et al.*, 2004).

Finally society (or: politics) may hold the opinion that flood damage should never exceed a certain predetermined threshold. The costs of measures this from being exceeded may be considered as a kind of insurance premium to prevent us from suffering from a disaster we don't want to face.

#### *Differentiation of flood protection levels between polders*

Even when the probability of flooding would be equal, the risks differ strongly because of the large differences in potential flood damage. Moreover, in practice, flood probabilities are not at all equal, but differ for two reasons:

1. Uncertainty margins in flood probabilities are large, as dikes are not of uniform design or construction, other failure mechanisms than overtopping cannot be excluded, and the behaviour of the river and the water levels cannot be predicted sufficiently accurately.
2. In case of above-design discharge waves in rivers, the upstream polders are most likely to be hit first resulting in a drop of the water level in the river and thus safeguarding the polders further downstream from flooding (Van Mierlo *et al.*, 2003).

This asks for considering a more adequate differentiation of flood protection levels of all the polders along the Netherlands' rivers, tuned to potential damage levels. Due to the complexity of the hydraulic functioning of the river system and the large number of uncertainties we consider it not useful to specify a separate protection level for each polder. Rather a few roughly defined but distinct protection levels should be chosen for a preset flooding sequence. Then we would first have to establish the basic protection level for the polder that is allowed to be flooded first. All levees along the river must at least reach this level. Because of the many uncertainties, some additional dike height may be needed. But little extra should suffice, as further protection is

offered to the vulnerable polders by the successive inundation of the less vulnerable polders.

#### *Structural and non-structural measures*

Flood control measures encompass structural measures (constructions), non-structural measures (monitoring, early warning systems) and emergency measures (sand bags, flood logs). Structural measures offer security at high costs (investments, operation and maintenance). When time intervals between flooding events are expected to exceed the technical-economic life-time of constructions, they may not be used at all. Emergency measures are less secure. However, costs are made only when the situation is actually threatening. Although the costs of emergency measures are generally high, the present value may be rather low. After all, the present value of emergency measures decreases with the decreasing frequency of use, and, by consequence, emergency measures become economically more attractive in comparison to structural measures with decreasing flooding frequency.

Emergency measures may be considered for natural river valleys where water depths are restricted. That holds for urban areas in the Meuse valley in the Netherlands. For low-lying and vulnerable polders emergency measures are less attractive as these measures are less secure and the consequences of failure will be very severe. For low-lying and vulnerable polders structural measures are preferable.

#### *Sharing responsibility between government and inhabitants of polders*

Citizens and businesses in polders may prepare themselves for a flood and take measures to decrease the potential flood damage. Increasing the flood risk awareness and preparedness of the people lowers the psychological vulnerability.

But, the lower the frequency of flooding, the stronger the tendency of the threatened people and businesses to place all responsibility in the hands of the authorities (Kron and Thumerer, 2002). When the flooding frequency is low, it is very difficult to increase the flood risk awareness and to maintain it when nothing happens for decades. The collective memory plays an important role and that memory fades away with the years. For that reason along the Loire in France they refrain from constructions that are seldom used, as people tend to forget the purpose of those (Dijkman *et al.*, 2003).

Altogether, increasing the responsibility and preparedness of people and businesses as part of a flood risk management strategy is possible only when the frequency of flooding is relatively high. This then would apply to the floodplains as well as to the natural valley of the Meuse River, but obviously not to the dike-protected low-lying polders in the Netherlands, where the flooding frequency is far too low.

#### *Compensation of damage and insurance*

Inundation is done on purpose to save other areas. As a consequence costs and benefits should be distributed over society in a fair way. It means that inhabitants and businesses in inundation polders should be entitled to compensation of flood damage. We



consider the settlement of damages to be an essential part of a flood risk management strategy.

People would also like to be financially compensated in case of uncontrolled accidental flooding. Insurances may offer financial security. Kron and Thumerer (2002) state that the most efficient way to cope with flood's destructive forces is by a co-operation between the people and the government, plus the insurance industry. In recent years, the demand for flood insurance has been growing worldwide (Kron and Thumerer, 2002), but in the Netherlands it is at present impossible to get a private insurance for an uncontrolled flooding resulting from a dike breach.

#### *Base for determining the level of damage compensation*

The base for repayment of flood damages must be made clear and should be included in a flood risk management strategy. A generous compensation of flood damages will contribute to relieving the societal opposition when e.g. assigning calamity polders. The NIMBY-effect (Not-In-My-Back-Yard) may be changed to AIMBY (Allowed-In-My-Back-Yard).

What does generous mean in this case? It is clear that compensation of economic (tangible) damage alone is not enough. Compensation is also needed for inconvenience, stress, etc. Presently, we do not have a clue about the size of the intangible damage compared to the tangible damage. However, the value of the intangibles can be determined with the Contingent Valuation Method, by asking people how much financial compensation they wish for the burden of flooding. Usually, people will then react in a strategic way and will ask more than they really expect to receive. But such an asking price can be used as a starting point for negotiations with the government, eventually leading to a balanced price.

#### **Final comments**

In the Netherlands, a discussion has started on the further development of the present flood risk management strategy. Of course, as pointed out in the section on psychological aspects and communication, this should be done in close co-operation with the citizens and other parties, and especially with the people and businesses that may be affected in one way or another. They should be involved from the beginning, i.e. from the problem formulation, through the design of measures and their analysis, to the end, i.e. the evaluation of alternatives and the real decision making. This calls for intensive communication with all parties involved, in a language people understand easily, whilst being honest about all uncertainties, and sincerely taking into account the feelings of the people involved.

#### **References**

1. Anonymous (1998). "Lutte contre les crues et les inondations en Loire moyenne. A l'heure du bilan. *La Loire et ses*

- terroirs – le magazine du fleuve et des hommes;*" Dossier – No. 30, winter 1998–99, Philippe Auclerc, Combleux.
2. ARVAL, J.L. (2003). "Using Risk Communication to Disclose the Outcome of a Participatory Decision-Making Process: Effects of the Perceived Acceptability of Risk-Policy Decisions," *Risk Analysis*, 23(2), 281–290.
3. BAAN, P.J.A. (2003). "Coping rationally with flood risks?" (in Dutch: *Nuchter omgaan met overstromingsrisico's?*), *H<sub>2</sub>O*, 36(23), 41–43.
4. BAAN, P.J.A. and KLIJN, F. (2003). "Safety approach for flooding: improving preparedness?" (in Dutch: *Veiligheidsbenadering bij overstromingen: naar meer zelfredzaamheid?*) *H<sub>2</sub>O*, 36(18), 17–18.
5. BAAN, P.J.A. and RABOU, J.P. (2002). "Feelings with assignment and use of calamity polders and side rivers," (in Dutch: *Gevoelens bij aanwijzen en gebruik van retentiegebieden en groene rivieren*). WL | Delft Hydraulics, report Q2975.25. Delft, the Netherlands, March 2002.
6. BARNES, P. (2002). "Approaches to community safety: risk perception and social meaning," *Australian Journal of Emergency Management*, autumn 2002, 15–23.
7. BRUIJN, K.M. DE (2004). "Resilience and flood risk management," *Water Policy*.
8. DRABEK, T. (1986). *Human Systems Responses to Disaster: An Inventory of Sociological Findings*. Springer-Verlag, London.
9. DIJKMAN, J. *et al.* (2003). "Explanation of expert judgement for calamity polders," (In Dutch: *Toelichting aanvullend deskundigenoordeel noodoverloopgebieden*). WL | Delft Hydraulics, report Q3570. Delft, the Netherlands. August 2003.
10. DYNES, R.R. (1998). *Noah and Disaster Planning: The Cultural Significance of the Flood Story*. University of Delaware Disaster Research Center, Preliminary paper No. 265.
11. FLINTERMAN, M.H., GLASIUS, A.T.F. and VAN KONIJNENBURG, P.G. (2003). *The Perception of Flood Risks* (In Dutch: *De perceptie van overstromingsrisico's*). Bouwdienst Rijkswaterstaat. Utrecht, the Netherlands. January 2003.
12. HOOIJER, A., KLIJN, F., KWADIJK, J. and PEDROLI, B. (eds.) (2002). *Towards sustainable flood risk management in the Rhine and Meuse River basins; main results of of the IRMA-SPONGE research program*. NCR-publication 18-2002. ISSN 1568-234X.
13. HOOIJER, A., KLIJN, F., PEDROLI, G.B.M. and VAN OS, A. (2004). "Recommendations for Sustainable Flood Risk Management in the Rhine and Meuse River Basins: a Synopsis of the Findings of IRMA-SPONGE," *River Research & Applications* 20/1(2004): . . . . .
14. KLIJN, F., VAN BUUREN, M. and VAN ROOIJ, S.A.M. (2004). "Flood Risk Management Strategies for an Uncertain Future: Living with Rhine River floods in the Netherlands?" *Ambio* 33(2004)/3:141–147.
15. KRON, W. and THUMERER, T. (2002). *Water-related disasters: Loss trends and possible countermeasures from a (re-)insurers viewpoint*. Munich Reinsurance Company,

- Germany ([http://www.mitch-ec.net/workshop3/Papers/paper\\_thumerer.pdf](http://www.mitch-ec.net/workshop3/Papers/paper_thumerer.pdf)).
16. LYKLEMA, S. (2001). *Water management and communication: a study on the social basis of water management in the Netherlands* (in Dutch: Water beheren en communiceren: een studie naar het publieke draagvlak over het waterbeheer in Nederland). Thesis Wageningen University, the Netherlands.
  17. MIERLO, M.C.L.M. VAN, VROUWENVELDER, A.C.W.M., CALLE, E.O.F., VRIJLING, J.K., DE BRUIJN, K.M. and WEERTS, A.H. (2003). *Effects of River System Behaviour on Flood Risk*. Delft Cluster Publication number DC1-211-1. June 2003.
  18. PENNING-ROUSELL, E. (2003). Implementing flood mitigation and protection: constraints, limitations, power and 'reality', in M. Marchand, K.V. Heynert, H. van der Most and W.E. Penning (eds.), *Dealing with Flood Risk*. Proceedings of an interdisciplinary seminar on the regional implications of modern flood management. Delft Hydraulics Select Series 1/2003. Delft University Press.
  19. REES, J.A. (2002). *Risk and Integrated Water Management*. Global Water Partnership, TEC Background papers, No. 6. Elanders Novum, Sweden, August 2002.
  20. QUARANTELLI, E.L. (1989). *How individuals and groups react during disasters: planning and managing implications for EMS delivery*. University of Delaware Disaster Research Center, Preliminary paper no. 138.
  21. Rijksinstituut voor Volksgezondheid en Milieu (RIVM, 2003). *Coping rationally with risks* (in Dutch: Nuchter omgaan met risico's). Milieu-en natuurplanbureau RIVM, report 25170104/2003 ([www.rivm.nl/bibliotheek/rapporten/251701047.html](http://www.rivm.nl/bibliotheek/rapporten/251701047.html)).
  22. Raad voor de Volksgezondheid and Zorg (RVZ, 2001). *Prediction, prevention and insurance of health risk* (in Dutch: Gezondheidsrisico's voorzien, voorkomen en verzekeren). Advise to the minister of Health, Well-being and Sports, Zoetermeer, the Netherlands.
  23. REHMAN-SUTTER, C. (1998). "Involving Others: Towards an Ethical Concept of Risk," *Risk: Health, Safety & Environment*, 9, 119–136.
  24. SCHERER, C.W. and CHO, H. (2003). "A Social Network Contagion Theory of Risk Perception," *Risk Analysis*, 23(2), 261–267.
  25. SILVA, W., DIJKMAN, J.P.M. and LOUCKS, D.P. (2004). "Flood Management Options for The Netherlands," *Journal for River Basin Management* 2(2004)/1: . . . . .
  26. SJÖBERG, L. and DROTTZ-SJÖBERG, B.M. (1994). *In Radiation and society: comprehending radiation risk*. Proceedings of an International Conference in Paris, 24–28 October 1994. Vol I Wenen, International Atomic Energy Agency.
  27. SJÖBERG, L. (2000). "Factors in Risk Perception," *Risk Analysis*, 20(1), 1–11.
  28. SLOOTWEG, R. and VAN SCHOOTEN, M. (2002). *Social Aspects of Calamity Polders* (in Dutch: Sociaal-maatschappelijke aspecten van noodoverloopgebieden). Report SEVS Beleidsadvies voor natuur en leefomgeving. Oegstgeest, the Netherlands, 14th March 2002.
  29. SLOVIC, P., FINUCANE, M.L., PETERS, E. and MACGREGOR, D.G. (2002). *Risk as Analysis and Risk as Feelings. Some thoughts about Affect, Reason, Risk and Rationality*. Paper presented at the Annual Meeting of the Society for Risk Analysis, New Orleans, Louisiana, December 10, 2002 ([www.decisionresearch.org/pdf/dr502.pdf](http://www.decisionresearch.org/pdf/dr502.pdf)).
  30. SLOVIC, P. and WEBER, E.U. (2002). *Perception of Risk Posed by Extreme Events*. Paper prepared for discussion at the conference 'Risk management strategies in an Uncertain World'. Palisades, New York, April 12–13, 2002 ([www.ldeo.columbia.edu/res/pi/CHRR/Roundtable/slovic\\_wp.pdf](http://www.ldeo.columbia.edu/res/pi/CHRR/Roundtable/slovic_wp.pdf)).
  31. STEFANOVIC, I.L. (2003). "The Contribution of Philosophy to Hazards Assessment and Decision Making," *Natural Hazards*, 28, 229–247.
  32. STARR, C. (1969). "Social Benefits versus Technological Risk: What is our Society Willing to Pay for Safety?" *Science*, 165, 1232–1238.
  33. TAPSELL, S.M., TUNSTALL, S.M. and PENNING-ROUSELL, E.C. (1999). "The Health Effects of Floods' The Easter 1998 Floods in England," *Flood Hazard Research Centre Article Series*, No. 3/99.
  34. VALK, M., HEINEN, H., LEINWEBER, M. and OTTEN, J. (2003). *Awareness of Water in the Netherlands: Learning of Risk Awareness Processes in Foreign Countries* (in Dutch: Waterbewustzijn in Nederland: Lereren van risico-bewustwordingsprocessen in het buitenland. RIKZ/Bouwdienst/Ergo, Report nr. RIKZ/2003.005, the Hague, the Netherlands.
  35. VIS, M., KLIJN, F., DE BRUIJN, K.M. and VAN BUUREN, M. (2003). "Resilience strategies for flood risk management in the Netherlands," *Journal for River Basin Management* 1(2003)/1: 33–40.
  36. VLEK, C.A.J. (2001). Psychology of risks: each advantage has its risk (in Dutch: Risicopsychologie: elk voordeel heeft zijn risico). *Hypothese, kwartaalblad voor onderzoek en wetenschap*, jaargang 8, no. 31, pp. 12–15.
  37. VLIJGER, W. DE, LAGEWEG, M.C.C., VOLLERING, D.C. and BAKKER, J. (1998). *Study on Experiences and Feelings with High Water Levels* (In Dutch: Belevingswaardenonderzoek: Risicobeleving Hoogwater. Bouwdienst Rijkswaterstaat, the Netherlands. February 1998.
  38. WEBER, E.U., BLAIS, A.R. and BETZ, N.E. (2002). "A Domain-specific Risk-attitude Scale: Measuring Risk Perceptions and Risk Behaviors," *Journal of Behavioral Decision Making*, 15, 263–29.
  39. WERFF, P.E. VAN DER (2000). *Nature or neighbour in Hell's Angle: Stakeholders response to future flood management plan for the Rhine River*. IVM report D-00/10, SIRCH Working paper 9, Free University Amsterdam, December 2000.