Chapter 9

The illusion of safety: its existence, forms and remedies

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9.1 INTRODUCTION

Lack of awareness of the possibilities and consequences of rare catastrophic events, among people that may be potentially affected by them, is a crucial factor that can drastically increase the negative consequences of disasters when they occur. As a rule, lack of awareness results in inadequate preventive

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measures being taken against catastrophes and insufficient preparedness for them. In the case of large risks with low probabilities it is no surprise that most people are not sufficiently aware of a threat, having little or no experience with the event occurring. In this respect, the situation can be improved by educating those at risk about the danger and by taking precautionary measures – in particular, providing technical safety devices – at the population level. This, however, can have one potentially counterproductive effect: such provision can develop an excessive sense of safety among the people to be protected, making them eschew prudent behaviour and neglect the existing risk (e.g., by failing to purchase insurance). For instance, while building levees to protect a locality against flooding never reduces flood risk to zero – as pointed out by Kundzewicz and Kaczmarek (2000), 'a flood protection system guaranteeing *absolute* **safety** is an **illusion**' – it can make the inhabitants feel so (unrealistically) safe that they neglect making individual preparations for a flood that are desirable in any event. Thus, technical measures aimed at protecting against disaster may create an *illusion of safety*.

What level of feeling safe is unrealistic (i.e., what is the 'illusion of safety')? How can it be detected and measured? In our opinion, the illusion of safety comprises two interrelated effects. First, the very existence of technical measures aimed at disaster prevention can reduce people's *worry* about the possibility of a disaster's realization. Second, on a more cognitive level, they can excessively decrease people's estimates of the probability of a catastrophe. Clearly, both effects can be expected to occur simultaneously (where people do think about probabilities). Here, we shall treat both degree of worry and the subjective probability of a disaster occurring as proxies for a sense of safety and compare them in different environments, in particular, in the presence versus absence of technical preventive measures.

Moreover, in the psychological literature the term 'illusion of safety' is usually used to denote a different though related phenomenon – namely, an increased sense of safety resulting from taking actions that in reality have nothing in common with real protection against prevailing threats. When expecting danger, or even facing uncertainty, superstitious people 'keep their fingers crossed', children (and some adults) take their teddy bears with them, etc., in the need to feel safe. There is abundant evidence (see, e.g., Schade & Kunreuther, 2002) of the often absurd 'precautions' taken by New York's inhabitants after the 2001 terrorist attacks on the World Trade Center. However, this phenomenon, while interesting, does not seem to occur *en masse* or to influence the decisions of many people threatened by catastrophic events.

On the other hand, the 'illusion of safety', when taken literally, is simply an unrealistic sense of being safe when a disaster is possible. Similarly to the phenomenon described above, it probably results from a general need for reassurance in the face of a large risk. Unlike the above phenomenon, it may lead to neglect in making necessary precautions and thus have serious practical consequences, including insufficient preparedness for the risk and higher losses in the event of its realization. Each of the biases involved in safety illusions – whether this be inadequately low levels of worry or underestimations of probability – clearly influence another interesting and important variable: the willingness to protect oneself against risk. On the other hand, there are numerous possible determinants of illusion of safety, both individual (optimism, attitude towards risk, general tendency to worry) and external (available information about risks, methods of communicating probabilities, the existence of protective measures).

In this paper we focus on the role of technical measures designed to reduce risk. The risk homeostasis theory formulated by Wilde (1982) predicts less prudent behaviour of decision-makers in the presence of such technical measures than in their absence. There is also abundant anecdotal evidence of drivers behaving more riskily in safer automobiles on safer roads, and of increases in the number of accidents on mountain climbing routes subsequent to the installation of safety devices such as iron rungs, chains and cables. It seems then, that the vigilance of 'protected' decision-makers is attenuated. Is this because of the illusion of safety? If so, is the illusion due to the provision of safety measures?

There have been few studies of the aforementioned effects thus far, and empirical results are mixed. Siegrist and Gutscher (2006) observed that inhabitants of flood-endangered areas in Switzerland gave lower estimates of flood probability than experts, and Wouter Botzen *et al.* (2015) observed overestimation of flood probabilities among residents of New York City as compared to probabilistic flood risk models developed for the city. Also, Ludy and Kondolf (2012) reported very low worry levels and verbal risk assessments among inhabitants of a new levee-protected subdivision in California. However, it is unclear whether this was indeed a 'levee effect' or simply underestimation of the residual risk that might occur also in an unprotected area.

Systems of levees protecting flood-prone areas are a common and important example of a technical device reducing risk. We use these in our chapter to investigate whether and how the very existence of technical precautionary measures influences people's sense of safety. To this end, two studies were conducted. The first one used two hypothetical scenarios evaluated by a diverse range of people completing a questionnaire on the Internet. The second was a field study conducted on inhabitants of flood-prone areas in Poland with differing flood histories and differing qualities of existing levees. Respondents in both studies declared their level of worry of possible flooding, and in the field study they also estimated the probability of flooding.

9.2 STUDY 1: THE ILLUSION OF SAFETY IN THE LABORATORY

A preliminary study was conducted on the Internet to test whether the existence of protective measures does, *ceteris paribus,* influence people's perceptions of security. We hypothesized that 'protected' decision-makers would display lower levels of worry and lower willingness to buy insurance than those 'unprotected'. To test this, two groups of participants – one 'protected' and one 'unprotected' – were asked to assess their level of worry about the possibility of their house being flooded in a hypothetical scenario. We attempted to compensate for the obvious weaknesses of hypothetical studies by eliminating all real-life elements that differentiate situations and influence respondents' answers in any field study: except for a single difference (the existence versus lack of levees) between the groups, the two scenarios were identical, making the decision situations of all respondents within a group identical, and those for the two groups indeed *ceteris paribus*. In particular, no information about the probability of flooding was given to participants, and the physical conditions for a flood's occurrence were exactly the same in the protected and unprotected groups.

9.2.1 Participants

Seventy-three participants recruited on an Internet platform, 55 men and 18 women, aged between 20 and 65 years ($M = 34.1$ years, $SD = 9.7$ years) took part in the study. Another 13 people completed the questionnaire but were rejected because they answered all of the questions in an unfeasibly short time (less than 3 minutes), suggesting that they had not read the scenario carefully.

9.2.2 Procedure, scenarios and questions

Participants were randomly assigned to the unprotected group ($n = 40$) or protected group ($n = 33$) and read one of two scenarios about the flooding of a house recently bequeathed to them. They were then asked to answer a number of questions including one about their level of worry and one about their readiness to buy home insurance. Thereafter, they were asked about their real-life experience of floods and completed an abbreviated version of the Worry Domain Questionnaire (WDQ; Stöber & Joormann, 2001). The whole study was conducted online in Polish. Participants were paid 6 PLN (around $2) for their participation.

Scenarios:

> [ALL PARTICIPANTS] Your relatives had a house and informed you long ago that they were going to bequeath it to you. Now you have inherited the house and you can move in. It is a valuable and comfortable house located in a nice neighbourhood. However, it has one shortcoming: it has been built close to a river, in an area that is threatened by inundation. In the event of a very large flood your house will be flooded and seriously damaged – it will become unfit for living in and the cost of restoring it will amount to about a half of its present value, that is, about 250,000 PLN.

[PROTECTED GROUP ONLY] The area has been recently protected by a new levee that will protect it against normal floods but not against extreme floods.
[UNPROTECTED GROUP ONLY] No means of protecting against floods are present in the area, nor are any planned.
[ALL PARTICIPANTS] On the way to your house there is a gauge on the river showing the current level of the water. You know that your house will be flooded if the water exceeds the highest point on the gauge's scale by more than 1 metre. You also know that the last time such a flood happened was 30 years ago.

Questions

(1) When living in the house, to what extent would you be worried about the possibility of your house being flooded?
(5-point scale, from 0 – Not at all, to 4 – I would be very worried)
(2) There is the possibility of buying insurance against flooding. The insurance costs 850 PLN a year and covers all damage if your house is flooded. Would you buy the policy?
(5-point scale, from 0 – Certainly not, to 4 – I would certainly buy)
(3) In your opinion, would other people in the same circumstances be less or more worried than you?
(5-point scale, from –2 – Much less, to 2 – Much more, and 'I do not know')

9.2.3 Results

A comparison of levels of worry about the house flooding across the two groups strongly confirmed the existence of a safety illusion. The mean level of worry in the unprotected group ($M = 2.58$, $SD = 1.06$) was higher than that in the protected group ($M = 2.00$, $SD = 1.03$), and this difference was significant, $t(71) = 2.34$, $p = 0.022$ (two-tailed); Mann-Whitney $U = 472$, $p = 0.030$. Even though obtained in a purely hypothetical study, this result is of considerable interest. Moreover, this form of safety illusion can clearly be attributed to the difference between the two scenarios and not to individual propensities to worry among the respondents: these propensities, as measured by WDQ scores, were positively correlated with contextual worry about damage to the house caused by flooding, but the correlation was non-significant ($r = 0.133$, $p = 0.399$). Also, as expected, the WDQ scores did not differ between groups.

On the other hand, the difference in levels of worry (or, alternatively, in perceived degree of safety) did not translate to differences in willingness to purchase insurance. The mean willingness to buy a policy for a (realistic and rather moderate) price of 850 PLN, measured on a five-point scale from 0 to 4, was 3.43 in the unprotected and 3.21 in the protected group (SDs = 0.64 and 1.02 respectively). This difference was non-significant, $t(71) = 1.09$, $p = 0.281$ (two-tailed). In both groups, a great majority of respondents, including most of those with low levels of worry, indicated they would ‘definitely buy’ or ‘rather buy’ the policy. Thus, it seems that the serious threat constituted by the flooding of one’s house makes people generally willing to insure themselves for a reasonable price, at least under a hypothetical scenario (where talk may be cheap). Presumably for the same reason, we did not observe the relationship between degree of worry and willingness to buy insurance that has previously been observed in many field and laboratory studies (e.g., Schade *et al.* 2012): for the present study the Pearson’s r correlation was positive but non-significant ($r = 0.10$, $p = 0.403$).

Only 19 out of 73 respondents reported any real-life experience of a house flooding (i.e., responded ‘Yes’ to the question ‘Has your house, or the house of a relative or friend, ever been flooded?’). These were mostly associated with the large flood of 1997 or 2010, and, of the 19 respondents, 4 stated that is was their own house which flooded. This number of respondents is too low to confirm any statistical impact of such an experience on the dependent variables in the study. However, there was virtually no difference in degree of worry between the experienced and unexperienced groups ($M = 2.37$, $SD = 1.06$ and $M = 2.30$, $SD = 1.09$, respectively). This showed that it was indeed the existence or lack of dikes in scenarios that accounted for level of worry about the house flooding. Thus, the illusion of safety seems to be a real psychological phenomenon deserving of further study in the field.

9.3 STUDY 2: THE ILLUSION OF SAFETY IN THE FIELD

While the laboratory study strongly confirmed the safety illusion phenomenon, its observation in real-life circumstances would emphasize its practical significance. Therefore, we also attempted to detect its existence in the field. The advantages and disadvantages of laboratory versus field studies are well-known, and a comparison of results observed for the same phenomenon in both contexts provides a very attractive research perspective, albeit that a field study does not allow replication of the precisely controlled conditions in a laboratory experiment. To study the illusion of safety in the field, face-to-face interviews were conducted in June 2016 with inhabitants of a number of localities along the Vistula with various histories of inundation and various states of protective levees. To measure people’s sense of safety, respondents were asked about their level of worry associated with the possible flooding of their houses. We also asked them to estimate the probability of their house flooding within the next year and the next 20 years. Numerous real-life variables that could potentially affect participants’ sense of safety were controlled, including their experience of flooding.

As before, we hypothesized that people living in protected areas would worry less and estimate the probability of flooding as lower than those living in areas facing similar flood probabilities but not protected.

9.3.1 The participant sample

The study was conducted on a sample of 186 adults living in selected localities close to the Vistula river.

In addition to many of its tributaries, the Vistula – the largest river in Poland – rises in the Carpathian Mountains where heavy rainfalls occur relatively frequently, particularly in summer. This causes huge variations in its flow rate. Even in Warsaw, more than 500 km from its sources, the maximum recorded flow rate of the Vistula (5650 m^3/s) is 10 times the average (561 m^3/s) and above 50 times the minimum. Almost every decade a serious flood occurs on the middle and/or upper Vistula, caused either by rainfalls in southern Poland or (nowadays less frequently) rapid snowmelts. Within the last two decades, catastrophic floods occurred in 1997, 2001 and 2010.

With the exception of some city areas and bridges, the Vistula flows in its natural bed and is not canalized. Almost all localities on the river that are potentially threatened by floods are protected by levees. The levees are normally designed to protect the terrain against '100 year' floods but in practice are of different ages and qualities; some were broken during the last flood occurrence, which resulted in a large amount of damage, and some are known to be highly vulnerable or, in a few cases, lower than required.

All flood-prone areas in Poland, except the mountain regions, have been mapped by the Polish Institute of Meteorology and Water Management under the ISOK (Informatyczny System Osłony Kraju [IT System for the Country's Protection against Extreme Hazards]) project. Using existing hydrologic data, mathematical modelling and the Digital Terrain Model, areas that would be inundated by a 10 year, 100 year and 500 year flood (with equivalent yearly flooding probabilities of at least 10%, at least 1% and at least 0.2%, respectively) have been identified. These ISOK flood hazard maps – an analogue of United States FEMA (Federal Emergency Management Agency) maps – are now publicly available (ISOK, 2015), and our study used them to select the localities in which interviews were conducted. For the purposes of the study it was assumed that areas situated in the same – for example, 1% – flood zone with similar levels of floodwater in the event of a 100 year flood faced the same risk of flooding.

In total, 186 people in 6 different localities were interviewed. All respondents lived in one-family houses, exactly half were female, and most (170) were heads of families. Their ages varied from 21 to 100 years ($M = 55.4$ years, $SD = 14.9$ years).

Respondents were divided into six groups, corresponding to the localities of their residence. Within each locality we selected areas with the highest flood risk according to the ISOK maps, and instructed our pollsters to interview the inhabitants of these areas first whenever possible. As a result, we obtained (as desired) a high proportion of respondents aware of the threat, that is, people believing that they lived in a flood-prone area (77% answered 'certainly' or 'probably' on a 4-point scale) and that their house was threatened by flooding (61%). Some of the localities are protected by levees and others not, and some, but not all, were flooded during the large flood of 2010. Data for the chosen localities are presented in Table 9.1, and their specific characteristics are in the appendix.

Table 9.1 Basic characteristics of localities in which the study was conducted.

Group	Locality/Localities	ISOK 0.2%	ISOK 1%	Protected	Flooded in 2010
I	Lucimia, Gniazdków	+	+	No	Yes
II	Janowiec	+	–	Yes	Yes
III	Borowa, Matygi	+	+	Yes	No
IV	Połaniec	+	+	No	No
V	Konstancin left bank	+	–	Yes	Partly
VI	Konstancin right bank	+	–	Yes	No

9.3.2 Method and questionnaire

Interviews were conducted face-to-face at respondents' homes, with the interviewer writing down respondents' answers.

The questionnaire consisted of 27 questions, some of them conditional on earlier responses. Along with declaring their **intensity of worry** about the possibility of their house being flooded, respondents were also asked to state a **subjective probability** of such an event occurring during the next year and within the next 20 years. The answers to these three questions were used as measures of the safety felt by respondents and were central dependent variables in the study. The questions read as follows:

(P1yr): Please give the chance, in per cent, that your house will be flooded within the next year (0 denoting no chance at all, 100 denoting certainty of flooding)

(P20yrs): Please give the chance, in per cent, that your house will be flooded within the next 20 years (0 for no chance at all, 100 for certainty of flooding)

(Worry): To what extent do you feel worried about the possibility of your house being flooded?

[4-point scale, from 1 – I definitely do not worry, to 4 – I definitely do worry]

The questions about probabilities were asked in random order, and only to respondents who did not answer 'certainly not' to an earlier question on awareness of danger (see below).

These questions were preceded by two others about **awareness of flood risk**:

(Awareness – area): Is the locality of your residence threatened by flooding in the event of a flood?
(Awareness – house): Is your house threatened by flooding in the event of a flood?
[both on a 4-point scale, from 0 – certainly not, to 4 – certainly, with 2 = Difficult to say]

We also checked respondents' experience of past flooding, their opinions about the efficiency of protective measures (if they existed), their insurance status and their individual protective activities. The relevant questions read as follows:

(Own house flooded): Has your house ever flooded?
(A close person's house flooded): Has the house of anyone close to you ever flooded?
(only asked of those who answered 'no' or 'I don't know' to the preceding question).
(Protection): Do any protective measures against flooding exist in the area of your residence?

…and if 'yes' was the answer above,

(Protection efficiency): In your opinion, will they protect your house in the event of a flood?
(Insured): Do you have an insurance policy against your house flooding?

…and if 'yes' was the answer above,

(Obligatory): Is this insurance obligatory?
(Individual prevention): Do you take any action on your own to protect your house from flooding?
In the case of a 'yes' answer, the respondent was asked to enumerate these actions.

Three ordinal variables with three possible values each were derived from the responses to the questions about past experience, efficiency and insurance:

Personal experience of flooding: 'own', 'of a close person' or 'none',
Perceived efficiency of protection: 'non-existent', 'inefficient' or 'efficient'
('efficient' equating with answers of 'certainly' or 'probably' to the 'efficiency' question)
Insurance status: 'voluntary', 'obligatory' or 'none'.

At the end of the procedure, respondents completed a short **optimism** questionnaire, which was a Polish adaptation of the LOT-R (Revised Life Orientation Test) questionnaire (Scheier *et al.* 1994) consisting of six relevant and four non-relevant items on a 5-point scale, with possible total scores ranging from –12 to 12. Respondents also supplied demographic data: age, marital status and duration of residence at the present address. All respondents were offered a small gift for the time they devoted to their interview.

9.3.3 Results

9.3.3.1 Worry and subjective probabilities – intergroup comparisons

As mentioned previously, we measured feelings of safety by declared worry and subjective probabilities of the occurrence of a disaster. Therefore, the main dependent variables in the study were responses to the items **Worry, P1yr** and **P20yrs**. In this subsection we compare these variables across groups defined by locality of residence, and assume that localities situated in the same ISOK flood zone face approximately the same risk of flooding whether they are protected or not. It was hypothesized that both worry levels and subjective probabilities would be lower in protected localities, thus confirming the existence of the illusion of safety. In the next subsection we treat the dependent variables as functions of individual respondents' characteristics.

It should be noted that, although respondents were not expected to use formal probabilistic reasoning, their answers to questions about 1-year and 20-year probabilities were reasonably consistent. While 15 out of 165 respondents asked about probabilities replied '50%' to both questions, only two reported their 1-year probabilities as higher than their 20-year probabilities.

There were few significant differences between the groups with respect to **worry**. A one-way analysis of variance (ANOVA) for this dependent variable for the group independent variable revealed a significant main effect, $F(5,161) = 2.56$, $p = 0.029$, but pairwise comparisons of worry levels between groups revealed only significant differences between group **I** on the one extreme ($M = 2.93$, $SD = 0.98$) and groups **IV** ($M = 2.24$, $SD = 0.52$) and **VI** ($M = 2.15$, $SD = 1.05$) on the other, with $t(52) = 3.12$, $p = 0.002$, and $t(52) = 2.86$, $p = 0.006$, respectively.

A somewhat more transparent picture was obtained when restricting analysis to four 2×2 combinations of the protected x flooded factors. This could be done using groups **I, II, IV** and **VI** or, alternatively, groups **I** to **IV**. A graphical representation of these worry levels is presented as Figure 9.1, with flooding record and protection status of localities shown. Two-factor ANOVAs demonstrated that in both cases it was the flooding factor that had a significant impact on worry ($p < 0.001$, and $p = 0.016$), while both the effect for the protection factor and the interaction between the two factors were non-significant. So, residents of areas that had been flooded were more worried by the possibility of flooding than those of other areas, regardless of whether their localities were protected by levees or not. A psychological interpretation of this would be that experience of a disaster in one's locality, being an order of magnitude stronger than the 'experience of being protected', affects the highly emotional variable, worry.

The very strong impact of a locality's flooding record also pertained to the more cognitive dependent variables: subjective probabilities of future flooding (see Figure 9.2). However, these probabilities were also influenced by protection status, although not always directly. Somewhat surprisingly, this held mainly for the short-term **P1yr** dependent variable. One-year probabilities were influenced significantly by both a locality's flooding record (flooded versus not flooded) and its protection status (protected versus unprotected), and by their interaction (in a two-way ANOVA, $p < 0.001$, $p < 0.001$ and $p = 0.005$, respectively for groups **I, II, IV** and **VI**, and $p = 0.012$, $p = 0.035$ and $p < 0.001$ for groups **I** to **IV**). On the other hand, 20-year probabilities (**P20yrs)** were highly influenced by flooding record and the interacting factors ($p < 0.001$ for both, regardless of the groups used) but not directly by protection status alone ($p = 0.056$ or $p = 0.528$, depending on the 'protected and not flooded' group chosen). It seems that inhabitants of protected localities perceive levees as providing reliable short-term protection, but not necessarily long-term protection (possibly in some cases due to past experience of levee failures).

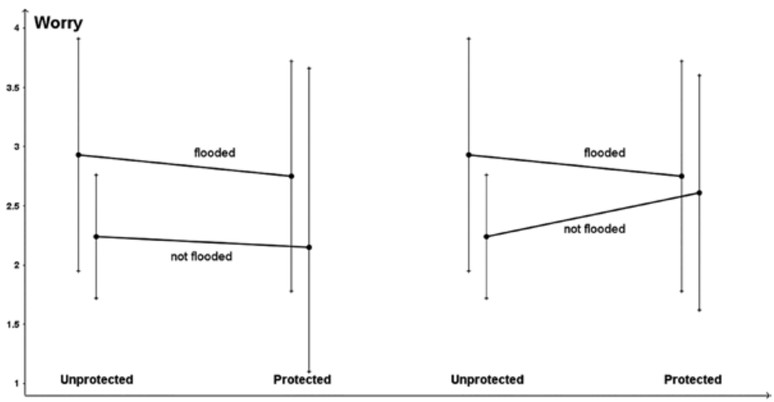

Figure 9.1 Worry levels in groups **I, II, IV** and **VI** (left) and **I** to **IV** (right).

Some pairwise comparisons between groups supported this conjecture. Groups **V** and **VI** resided on the opposite sides of a minor tributary (the Jeziorka); both areas are threatened by the Vistula's backwater but are protected by levees. In 2010, several houses in group **V** were (moderately) flooded, and a few others in both groups inundated by ground water. After that, the dike protecting group **VI** was renovated. Group **VI** reported significantly lower estimates of one-year flooding probability than group **V**, $t(49) = 2.01$, $p = 0.050$, also, a number of its members were certain that they did not live in a flood-prone area, but the two groups do not differ in their 20-year probability estimates or their worry levels.

The relatively weak influence of protection status on worry and long-term subjective probabilities was clearly caused by group **IV** (Połaniec) which was not protected and was not flooded in 2010. This combination is strange at first sight since all the other unprotected localities on the Vistula which are classified as flood-prone have been flooded in the last two decades, mostly more than once. Despite this, the members of group **IV** worried relatively little and, moreover, provided very low long-term flooding probability estimates, which was at variance from what might be expected from inhabitants of an unprotected area. They also displayed relatively low awareness of the threat to their houses (though not to their locality), and only one respondent in this group reported personal experience of her house being flooded. This indicates that personal previous experience of the realization of a threat may be another important factor influencing sense of safety.

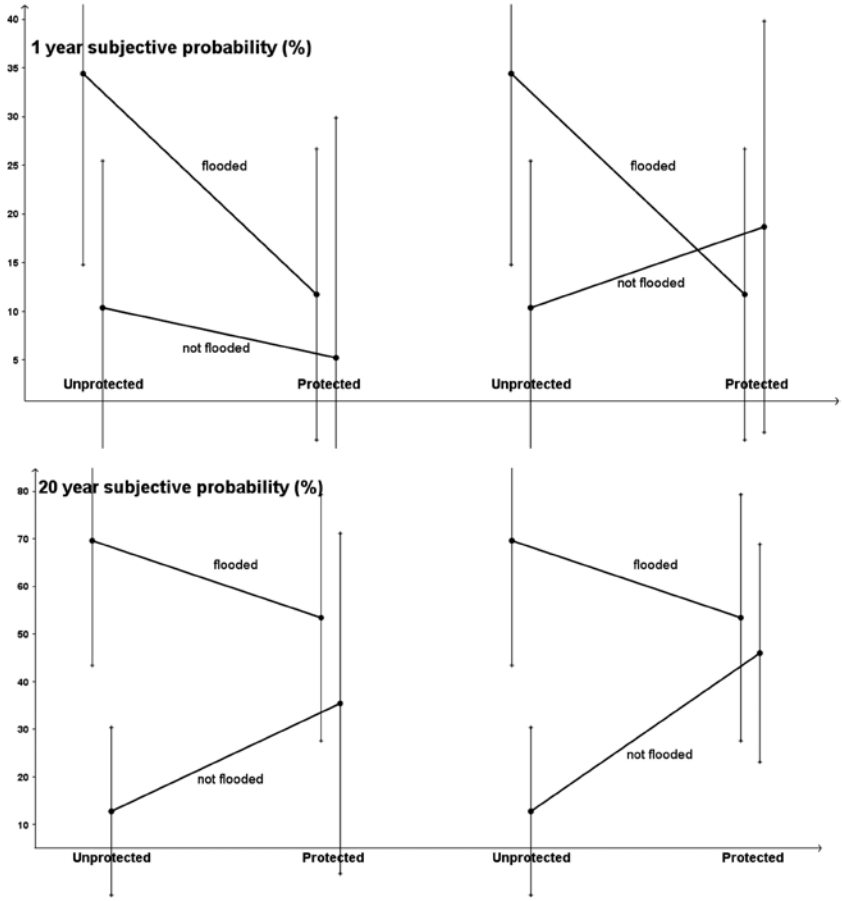

Figure 9.2 Subjective probabilities (**P1yr** and **P20yrs)** for groups **I, II, IV** and **VI** (left) and **I** to **IV** (right).

It can also be argued that a sense of safety is formed by one's own beliefs in the efficiency of protective measures rather than their simple physical existence. We shall discuss the influence of these beliefs, and of past personal experience of a disaster, on sense of safety proxies in the next subsection, conducting analyses on the entire sample of respondents, that is, with no division by location of residential groups.

Generally, the field results at the group level were ambiguous. *Ceteris paribus* conditions could be only very roughly approximated. Inhabitants of protected localities, whether flooded or not, worried less and provided lower disaster probability estimates than those of unprotected and flooded localities, but in general not than people in unprotected and non-flooded localities. For all three proxies of sense of safety, the impact of the flooding record of a locality was stronger than that of the existence of levees.

9.3.3.2 Worry and subjective probabilities – individual differences

In this subsection we place all respondents in one group and consider the impact of some individual characteristics of respondents on worry and subjective probabilities. The 'individual' counterparts of variables characterizing localities are **personal experience of flooding** (PExF) and **perceived efficiency of protection** (PEP) as defined in Section 9.3.1 (recall that each of these variables takes values 0, 1 or 2).

Both of the above variables, and their interaction, were strong predictors of **worry**, a two-two ANOVA yielding significance levels of $p = 0.004$, 0.003 and 0.016, respectively, $R^2 = 0.256$. For **1-year** probabilities, a 3×3 ANOVA showed a significant main effect of perceived efficiency of protection ($p = 0.002$) and only a marginally non-significant PEP x PExF interaction ($p = 0.051$) but, interestingly, no significant main effect of personal experience ($p = 0.244$). The factors accounted for a moderate proportion of variance, $R^2 = 0.119$. (This was consistent with the observation in the previous subsection on levees possibly perceived as a short-term protective device.) A similar R^2 of 0.118 was obtained for the **20-year** probability dependent variable, but in contrast here only personal experience was a significant predictor ($p < 0.001$, with $p > 0.14$ for both PEP and the interaction).

Moreover, the significant main effect of personal experience on the **P20yrs** and **worry** dependent variables was caused primarily by the 'none' (0) group: both worry and 20-year probabilities in this group differed greatly from those in other groups, while differences between the 'own' and 'close' groups were minor. Thus, experience of a disaster affecting a close person seems to be a good substitute for one's own experience. Efficient protection decreased **worry** in comparison to both inefficient protection (Tukey's HSD [honest significant difference], $p < 0.001$) and no protection ($p = 0.009$), and decreased **P1yr** estimates in comparison to no protection ($p = 0.003$) but not to inefficient protection ($p = 0.487$).

Apart from PExF and PEP, two other variables at the individual level had an influence on sense of safety, whether measured by worry or by probability estimates. As shown in Table 9.2, simple correlation analysis (Pearson's r) indicated strong links between these variables and general **optimism** (measured using a short questionnaire, see Section 3.1) and **duration of residence** at current address (in years).

Table 9.2 Correlation of some individual variables with sense of safety measures.

Variable		Correlation with		
		Worry	P1yr	P20yrs
Optimism	*r*	–0.222	–0.190	–0.276
	p	0.002	0.007	<0.001
Duration of residence	*r*	0.191	0.091	0.161
	p	0.007	0.123	0.020

Performing linear regression for each of the three main dependent variables with optimism and duration of residence as independent variables, we confirmed the conclusions drawn from the ANOVA analyses above and, in some cases, found that **optimism** was another important predictor, particularly of long-term probabilities.

Table 9.3 Linear regression analysis for proxies of sense of safety.

Dependent Variable: Worry	*B*	Std. Error	Beta	*t*	*p*
Constant	2.409	0.179		13.453	<0.001
Experience of flooding	0.366	0.088	0.307	4.180	<0.001
Perceived prevention	–0.210	0.080	–0.186	–2.621	0.010
Optimism	–0.033	0.017	–0.139	–1.915	0.057
Duration of residence	0.005	0.004	0.103	1.397	0.164
Dependent Variable: P1yr	***B***	**Std. Error**	**Beta**	***t***	***p***
Constant	18.944	3.584		5.286	<0.001
Experience of flooding	3.241	1.753	0.145	1.849	0.066
Perceived prevention	–5.287	1.639	–0.241	–3.226	0.002
Optimism	–0.699	0.348	–0.155	–2.006	0.047
Duration of residence	0.031	0.072	0.034	0.429	0.668
Dependent Variable: P20yrs	***B***	**Std. Error**	**Beta**	***t***	***p***
Constant	35.725	5.865		6.091	<0.001
Experience of flooding	10.840	2.868	0.290	3.779	<0.001
Perceived prevention	–0.555	2.662	–0.015	–0.207	0.836
Optimism	–1.563	0.570	–0.207	–2.742	0.007
Duration of residence	0.054	0.118	0.035	0.453	0.651

It might be suspected that **optimism** itself could be a function of individual experience of flooding and perceived efficiency of protection, and although there was indeed a relationship it was rather weak, a two-factor 3×3 ANOVA with optimism as the dependent variable revealing a marginal interaction between

PEP x PExF ($p = 0.050$), but both the main effects of PEP and PExF being non-significant, and R^2 being rather low (0.059).

The results in this subsection are concordant with those obtained at the group level but offer a clearer picture. Again, individual perceptions of prevention were the most important determinants of 1-year probability estimates and completely irrelevant for 20-year probability estimates, but they also affected level of worry. Individual experience of flooding affected all three dependent variables but had a relatively small impact on short-term probability estimates. A possible explanation of this is that experienced people realize that flooding does not occur each year and use a kind of contrarian reasoning.

9.3.3.3 Decisions about insurance and individual prevention

The importance of safety illusion effects lies in the fact that they can negatively influence willingness to take actions preventing and/or mitigating a threat, particularly whether to purchase insurance and take individual precautions to prepare for the threat (e.g., in the context of flooding, maintaining drainage or insulating house walls).

With respect to insurance, respondents possessing obligatory policies (in particular, farmers in Poland are legally obliged to insure their property) were excluded from all analyses with insurance status as a dependent variable. With such people excluded, our data clearly showed that relatively few people insured their houses against flooding: in five of the six groups, 'no insurance' was the modal response, but buying insurance was relatively more common in the areas that had suffered from floods (47% insured versus 27% in other areas).

Elementary analysis indicated which groups of respondents tended to purchase insurance. In comparison to those uninsured, (voluntarily) insured respondents…

were **more aware of the danger** of their house flooding,
had **more experience of flooding**, $\chi^2(2) = 9.65$, $p = 0.008$,
were slightly more confident in the efficiency of protection, $\chi^2(2) = 5.33$, $p = 0.069$,
and provided **higher 20-year probability estimates**, $t(139) = 2.45$, $p = 0.015$,

…but *did not differ from uninsured respondents* with respect to **worry, 1-year probability estimates, optimism or duration** of residence. This result is of some interest since it confirms Tyszka and Konieczny's (2016) finding that worry does not matter in insurance decisions, contrasting with the results of Schade *et al.* (2012).

Moreover, relatively *few* inhabitants of *unprotected areas* possessed insurance against flooding if they were not obliged to. Only 12 out of the 53 respondents in the unprotected localities (groups **I** and **IV**) who had a choice to purchase insurance did so, while in all protected localities the number of voluntarily insured respondents was above 30% (however, it only exceeded 50% in the recently-flooded group **II**).

First cursory observations revealed that few respondents take any individual protective actions, the answer 'definitely not' being modal in almost all groups. The number of respondents who reported taking individual precautionary actions was too small for any meaningful statistical analyses. Such activities were somewhat more frequent in the unprotected and flooded group **I** (28%, versus less than 20% in all other groups) and among people who had experienced flooding of their houses (20% versus 12%), but even in these potentially more active groups they occurred unexpectedly rarely.

We attribute the above somewhat surprising result to the fatalistic nature of floods on large rivers, which are infrequent but catastrophic when they occur and very difficult to mitigate. When asked an open question about the first things to do in the event of an immediate flood threat to their house most respondents suggested evacuation or simply escaping, and quite a few stated that nothing can be done.

9.4 CONCLUSIONS

The safety illusion phenomenon in the context of natural hazards, understood as an unrealistic sense of safety resulting merely from the existence of technical preventive measures, is potentially important and calls for detailed study. We were able to clearly confirm its existence in an Internet survey with hypothetical scenarios where the level of worry of flooding in a group protected by levees was significantly lower than in an unprotected group even though all other details, in particular the necessary and sufficient condition of potential serious flooding of a house (exceeding a fixed and given level by the river) was identical in both scenarios. This shows that the very existence of a levee makes people feel safer than in a situation with the same objective exposure to danger but without levees. Thus, 'the levee effect' is a real psychological phenomenon.

Attempts to confirm its existence in the field face serious problems, the main one being difficulty in finding groups with differing technical protection status but the same objective exposure to a threat. We used the ISOK flood hazard maps to select localities with exposures that were theoretically similar, but it has to be borne in mind that this can only serve as a coarse approximation. In particular, these maps offer (approximate) probabilities of flooding due to high water exceeding a levee's level but not due to levee defects, and the majority of flood losses on the Vistula in the last few decades were caused by levee breaches.

Moreover, as expected and as confirmed in our study, the flooding history of a locality impacts feelings of safety even more strongly than a levee's existence, so this also has to be taken into account when choosing areas to study. In particular, it is necessary to include a locality that is not protected and has no flooding record when making comparisons. But almost all of the (few) unprotected localities shown as being exposed to risk have been flooded, and the only exception on the Vistula – parts of Połaniec (group **IV**) – produced highly specific findings, presumably because its location on a high bank of a minor tributary of the Vistula made its inhabitants feel as if they were protected.

Generally, the results obtained in the field study are ambiguous, and only some of them suggest occurrence of the safety illusion as understood in this paper. Still, let us summarize them to see how they relate to the illusion of safety hypothesis.

(1) A large majority of respondents were aware of living in flood-prone areas. This held for all localities, protected or not, and for those not flooded for decades. It seems clear from our data that living in the vicinity of a large river precludes the most naïve form of safety illusion: denial of the very exposure to danger. (However, this finding contrasts with that observed during the great flood on the Oder in 1997; and reported in Chapter 1 of this volume, where the flood was unanticipated by most people.)

(2) While it is difficult to derive precise flood probability estimates for specific localities, it seems that those reported by respondents were generally not biased downwards. Almost all estimates of one-year flood probabilities were higher than 1%, most exceeded 10% and many exceeded 20%. This is in accordance with the overestimation of small probabilities observed by, for example, Wouter Botzen *et al.* (2015), and in Chapter 3 of this volume. Similarly, in all groups except **IV**, mean estimates of 20-year flood probabilities were well above 30%, while the theoretical probability of flooding within 20 years in the ISOK 1% areas is less than 0.18. It was only group **IV**, with an average estimate of 12.77, which displayed a type of safety illusion caused by its specific geographic location rather than by the existence of dikes. (However, it could well be argued that such a location offers more reliable protection than do levees.)

(3) In all comparisons between groups defined by locality of residence, the flooding record of the locality was the crucial predictor of all measures of feelings of safety (worry, and 1-year and 20-year probability estimates). This is in perfect agreement with the results of many studies, including those of Tyszka and Konieczny (2016, this volume). In particular, it can be concluded that the flooding of a protected locality cures its inhabitants of any safety illusion, as evidenced by group **II** in our study.

(4) In intergroup comparisons as in (3), the ‘protection’ factor is a significant predictor of one-year subjective probabilities only. Thus, at least for this measure of feelings of safety, one can speculate about the existence of a safety illusion. It has to be kept in mind that, since *ceteris paribus* conditions were not achieved, we cannot discern whether this impact of protection status was indeed due to the illusion of safety or the protected localities simply enjoying lower objective one-year flooding probabilities than unprotected localities. (However, the ISOK maps may suggest the first possibility.) Whether this is the illusion of safety or a rational belief

in levees as providing reliable short-term protection, it disappears when we move to long-term expectations: for 20-year probabilities the effect of protection status became non-significant.

(5) In an analogy to (3), individual experience of flooding was a very strong predictor of worry and long-term probabilities when we analysed sense of safety proxies' dependence on personal experience and PEP.

(6) In an analogy to (4), individual perceptions of efficiency of protection were a strong predictor of one-year probability estimates. This can be interpreted in terms of a safety illusion: people may simply overestimate the efficiency of existing protective measures. Moreover, high beliefs in this efficiency also reduced worry.

(7) There were strong negative correlations between all measures of feelings of safety and individual optimism. However, although optimism levels largely differed among groups, these differences cannot be attributed to protection status, so this seems not to contribute to illusions of safety, if present. Rather, optimism together with a safety illusion leads to underestimation of risk.

(8) The illusion of safety may have serious practical consequences because of decreasing willingness to purchase insurance or to prepare for danger. In this study we could not confirm this for two reasons. First, two of our measures of feeling safe did not differentiate between insured and uninsured respondents, and the third one that did, long-term probability, did not exhibit a safety illusion effect. Second, we could not find a set of individual characteristics determining willingness to take protective actions since only a few respondents reported such actions. We attribute this last result to the fatalistic nature of floods on large rivers rather than to a safety illusion.

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APPENDIX

Characteristics of localities investigated in the field study

Group I: $P \geq 1\%$, unprotected, flooded in 2010 (Lucimia, Gniazdków; $n_1 = 32$) – two small villages on the Vistula, where some fragments of dikes are still missing.

Group II: $P \geq 0.2\%$, protected but flooded in 2010 because of a Vistula levee breach; the dike was reconstructed thereafter (Janowiec; $n_2 = 33$).

Group III: $P \geq 1\%$, protected, heavily flooded by the Vistula and Wieprz in 1960s, but not flooded since then (Borowa, Matygi; $n_3 = 35$).

Group IV: $P \geq 1\%$, unprotected, not flooded in 2010 (Połaniec; $n_4 = 26$) – a small town on the high bank of the Czarna, a minor tributary of the Vistula that did not suffer from the 2010 flood. All respondents' houses in this locality were situated within the ISOK 100 year flood area.

Group V: $P \geq 0.2\%$, protected, small parts flooded in 2010 by backwater on the Jeziorka, a small tributary of the Vistula; the Jeziorka dike is in need of renovation (Konstancin left bank, $n_5 = 31$).

Group VI: $P \geq 0.2\%$, protected, not flooded in 2010 (Konstancin right bank; $n_6 = 29$); the Jeziorka dike was recently renovated.

The 'left' and 'right' bank in Konstancin refer to the sides of the Jeziorka river.

P is the one-year probability of flooding according to the ISOK maps. All selected localities would be flooded by a once in 500 years water level, and none by a once in 10 years water level.