Chapter 11
Social Indicators of Vulnerability to Floods: An Empirical Case Study in Two Upper Tisza Flood Basins

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Abstract This chapter aims to develop indicators of social vulnerability related to flood impacts on the regional level. Impacts are seen here as a function of the exposure as well as the vulnerability dimensions. Because key vulnerability factors include several variables that cannot be found in statistical databases, such as preparedness to the hazard, mental coping capacity, social relations, and trust, an approach based on questionnaire surveys instead of only using statistical data from institutions was chosen. The analysis is based on an empirical survey conducted in the Bodrogköz area and in the Bereg region within the Tisza flood basins. We found that while the most important variables influencing impacts were the exposure level and the geographic location, the most important factors of vulnerability were found to be the following: health, education, savings, opportunities of taking loans, trust in the members of the community and in institutions, and perception of preparedness of institutions against floods. Based on the results we give some policy recommendations with regard to increasing the resilience of the exposed communities. These include: increasing public spending on education, strengthening social cohesion, introducing contingency loans so that borrowing is feasible also for the poorer communities and improving flood preparedness by providing relevant information for inhabitants.

Keywords Vulnerability to floods • Empirical survey • Case study • Upper Tisza river basin

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11.1 Introduction

In large parts of Europe, extreme weather events, such as heavy precipitation, wind storms and heat waves, are expected to become more frequent and intense in the future due to climate change (Parry et al. 2007; Alcamo et al. 2007). However, climate-related extremes already put a heavy burden on Europeans at different scales, from households, businesses and governments to the European Union. They differentially affect society depending on geography, as well as the economic, social and cultural context of those exposed, including age, health status, education, income, indebtedness, to name but a few factors contributing to vulnerability (Linnerooth-Bayer et al. 2005). Hence, a better understanding of the complex relationships of these factors will also help to decrease vulnerability against extremes more effectively not only for today but also in the future.

The term "vulnerability" is nowadays a concept with multiple and ambiguous meanings, used within a broad range of disciplinary contexts, including geography, anthropology, engineering sciences, ecology and economics. For example, while in the context of climate change, vulnerability is defined as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. [. . .] is a function of the character, magnitude and rate of climate change and the variation to which as system, is exposed, its sensitivity and its adaptive capacity" (IPCC 2007: 27). In the disaster community vulnerability is defined as "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard" (UNISDR 2003: 12). Hence, in the later terminology vulnerability is independent of its exposure. To make things even vaguer, in the disaster community it is common to use the notion of vulnerability more broadly, and usually vulnerability includes the element's exposure (UNISDR 2003). A more workable definition of vulnerability for this article comes from Turner et al. (2003), which defines vulnerability as the degree to which a system or subsystem is likely to experience harm due to exposure to a hazard, either as a perturbation or stressor. Most importantly in this approach vulnerability incorporates not only exposure but also resilience, now a key concept in vulnerability research, which refers to the capacity of the system to absorb disturbances and reorganize, while undergoing changes to retain essentially the same function, structure, and identity (Walker et al. 2002). Hence, resilience decreases vulnerability.

Still, at this level of complexity it is difficult to carry out any empirical research and focus on some dimensions of vulnerability is necessary. Generally speaking, the different dimensions can be grouped into physical, economic, social and environmental factors as listed below (Kohler et al. 2004):

- Physical: related to the susceptibility to damage of engineering structures such as houses, dams or roads. Also factors such as population growth may be subsumed under this category.

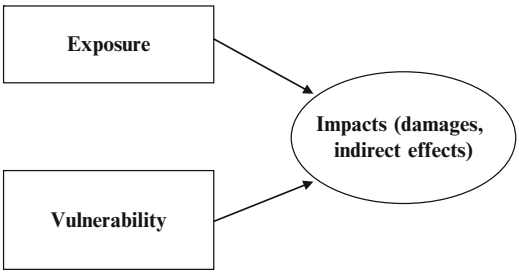

Fig. 11.1 Exposure to hazard, vulnerability and impacts

- Social: defined by the ability to cope with impacts on the individual level as well as referring to the existence and robustness of institutions to deal with and respond to natural disaster.
- Economic: refers to the economic or financial capacity to refinance losses and recover quickly to a previously planned economic activity path. This may relate to private individuals as well as companies and the asset base and arrangements, or to governments that often bear a large share of a country's risk and losses.
- Environmental: a function of factors such as land and water use, biodiversity and stability of ecosystems.

Furthermore, natural disasters may cause a variety of effects which are usually classified into social, economic, and environmental impacts as well as according to whether they are triggered directly by the event or occur over time as indirect effects. In this chapter social and economic vulnerability is looked at only, and exposure is treated as a separate variable, both together with vulnerability leading to damages and indirect effects (Fig. 11.1).

It is a central issue and one of the key goals in the vulnerability research community to find out what factors determine the vulnerability of individuals, communities, organizations and systems, and how vulnerability can be reduced (UNU–EHS 2005). Research suggests that in general, key social and economic dimensions of vulnerability include preparedness for managing the hazard, demography, economic situation, and education and skills, among others (Cutter 2005; Glatron and Beck 2008). The authors believe that in spite of commonalities, there are also substantial differences between main factors of vulnerability in various situations. Economic and social circumstances, institutional background, cultural characteristics and the type of hazard seem to be important determinants of key vulnerability factors.

The purpose of this chapter is to develop regional indicators of social and economic vulnerability to flood damages in the Upper Tisza region. We hypothesize that many key vulnerability factors cannot be found in statistical databases, such as preparedness to the hazard, mental coping capacity, social relations and trust, among others. For this reason we use a standardized questionnaire so that these variables can be incorporated within this study design.

The chapter is organized as follows: The next section introduces the questionnaire, sampling method and first exploratory results. Section 11.3 presents the

results separated according to bivariate and multivariate relationships found in the statistical analysis of the data. Finally, Sect. 11.4 ends with a discussion of the results and conclusions.

11.2 Methodology

11.2.1 Sample

A face-to-face questionnaire was administered in two high-risk flood basins (Bodrogköz and Bereg) of the Upper Tisza region,[1] with samples of 400 interviewees in 18 villages in the Bodrogköz area and 300 interviewees in 22 villages in the Bereg region. Data collection was conducted in January 2006 in Bodrogköz, and in August 2006 in Bereg. The interviewees were chosen randomly from the population by the demographical quota.[2] This quota ensured representativeness of the population in the sample with respect to gender of the respondents, their age (approximately half of the respondents consisted of adults below 29 years of age and above 60 years of age), and education (most respondents had less than 8 classes of primary school, with Bereg showing a larger amount compared to Bodrogköz).

11.2.2 Method

The purpose of the questionnaire was to obtain information from the respondents on their exposure, vulnerability and impacts from previous floods:

- *Exposure*: The water management authorities classify settlements according to their flood exposure; however, due to differences in elevation there is differential exposure even within one settlement. For this reason, we chose to rely instead on the respondents' self classification of their exposure as part of the questionnaire;
- *Vulnerability*: We initially hypothesized that flood vulnerability is related both to individual and community preparedness and to social and economic characteristics, such as health, education, economic activity, income, savings,

[1] Data collection was supported by the following organisations: United Nations University and the Research Institute for Soil Science and Agro-chemistry of the HAS (Bodrogköz); UNDP GEF, Directorate of the Hortobágy National Park and the Ministry of Environment (Bereg). Data processing was financed by the Department of Mathematics and Information Technology of Corvinus University.

[2] The data were collected from the census database (2001) of the Hungarian National Statistical Office.

Table 11.1 Exposure, vulnerability and impact sub-dimensions

I. Exposure		Exposure of the respondent's settlement to floods
		Exposure of the respondent's home to floods
		Personal experience concerning floods
II. Vulnerability	Preparedness	Preparedness of the respondent (and his/her family) for floods
		Preparedness of different institutions (government, local government, water authority, water associations) for floods
	Physical and mental health	Respondent's health status
		Respondent's lasting health damage or impairment
		Respondent's (mental) capacity of coping with problems
	Qualification	Respondent's educational level
	Economics	Respondent's economic activity and income
		Respondent's savings
		Respondent's opportunities for borrowing
	Social capital	Trust in members of the community and in institutions
		Respondent's social relations and isolation
		Civic activity of respondent
III. Impacts of floods		Respondent's (and family's) damages and disadvantages caused by recent floods
		Lasting effects of recent floods

and social capital.[3] As a basis for the questions, we made use of vulnerability indicators found to be relevant in the international literature (for example UNU–EHS 2005), as well as in the findings of our earlier research (Vári and Ferencz 2006);

- *Impacts*: Only a very small number of people have lost their lives in floods in Hungary during the past decades, and damages have been primarily of economic and social nature. Therefore we focused questions on exploring such impacts.

Table 11.1 lists the components of exposure, vulnerability and impacts that formed the basis of the survey questions.

11.3 Summary of Questionnaire Responses

In the following, we summarize the results of the questionnaire responses in Bereg and Bodrogköz before turning in the next section to examining the relationships among exposure, vulnerability and impacts. We present the results of bivariate analyses in which we test the significance of correlations using Chi-square tests and

[3] The concept of social capital includes trust, intra-community relations, and the strength of civil society and certain aspects of governance (see Putnam 1993; Fukuyama 1996).

Table 11.2 Responses to question asking how prepared were respondent, respondent's family and relevant institutions for floods in the past (average of a five-grade scale)

	Bereg	Bodrogköz
You and your family	2.07	2.31
The central government	2.42	2.11
The local government	2.49	2.32
The water management authority	2.59	2.51
The water associations	2.56	2.35

ANOVA model approaches.[4] The purpose is to give a comparison between the two selected flood hazard prone areas and to detect differences with regards to the vulnerability dimensions.

11.3.1 Exposure

In Bereg, the overwhelming majority of respondents regard their settlement as being either strongly or weakly exposed, and less than one tenth of the respondents believe that there is no danger of floods. Two thirds of Bodrogköz respondents regard their settlement as strongly or weakly exposed to floods, whereas one third hold that there is no such danger. Those who regard their home (weakly or strongly) exposed made up about 94% of those living in the exposed settlements of Bereg, and about 72% of those living in exposed settlements in Bodrogköz. A more detailed analysis showed that active earners and diploma-holders are overrepresented among those not exposed (i.e. those considering that either their settlement or their home are not exposed) in the Bodrogköz area, whereas the unemployed and people with primary education were over proportionally represented among the exposed. In the Bereg region there was no significant relationship between exposure and socio-economic variables. Inquiring if the respondents *had already experienced flooding*, 90% of the Bereg respondents reported living through a flood (89% experienced the 2001 flood in this region) and 33% had experienced multiple floods. In the Bodrogköz region 32% of the respondents had experienced flooding and 20% multiple floods. Exposed respondents were overrepresented among those who had experienced at least one flood, indicating a (significant) correlation between having experienced floods and perceiving a higher exposure.

11.3.2 Preparedness

Tables 11.2 and 11.3 present the assessment of past and future flood preparedness among people who had experienced floods in both regions. On a five-point scale,

[4] In the present chapter those interrelationships are mentioned from which significant relationships among variables can be shown, in other words we may state on the 95% confidence level that the variables are not independent of each other.

Table 11.3 Responses to question asking how prepared are respondent, respondent's family and relevant institutions for future floods (average of a 5-grade scale)

	Bereg	Bodrogköz
You and your family	3.0	3.09
The central government	3.16	2.91
The local government	3.24	3.16
The water management authority	3.37	3.26
The water associations	3.32	3.14

the average assessment was between 2.07 and 3.37. Assessments of past preparedness were lower in every category than for future preparedness, and Bereg was considered better prepared than Bodrogköz. Differences, however, between values of future and past preparedness were very similar in both regions, around 0.7. As far as institutions are concerned, people regard water management authorities as the most prepared in both regions, followed by water associations and local governments. The lowest scores were given to the central government, which reflects a general disappointment with central government agencies. In the Bodrogköz region the respondents assessed their own preparedness more positively than that of the central government, whereas people of Bereg regarded their own preparedness as less positive.

Interestingly exposed people considered themselves better prepared than those not exposed in both regions.[5]

11.3.3 Physical and Mental Health

The respondents were asked to *evaluate their own health status* on a five-grade scale. The average assessment was 3.32 in Bereg and 3.34 in Bodrogköz. In Bereg and Bodrogköz, there were larger proportions of women, pensioners, people above 50, those with primary education, and people having low (household) income, who assessed their health status as poorer. Alternatively, men, people between the ages of 18 and 39 (18 and 49 in Bodrogköz), active earners, those who had completed their secondary studies and those who had a medium or high income were over-represented among those considering themselves to have good health status. Women reported a significantly worse health status than men. Fifty per cent of men, whereas only 38% of women regarded themselves as in good health in the Bodrogköz region, while these proportions were 55 and 41% respectively in Bereg.

The respondents were also asked whether they *had lasting health damage or impairment*. From this question the population of Bodrogköz seems to be somewhat healthier: 28.9% reported having permanent damage to their health, as contrasted to Bereg, where this proportion was 33%. In Bereg, pensioners, people with primary education and those of the lowest income indicated permanent health damage above

[5] Opinions assessing the current situation in the Bereg region are an exception where the difference is within the margin of error.

Table 11.4 Employment status of interviewees (%)

	Bereg	Bodrogköz
Active earner	26.3	23.4
Pensioner	42.0	39.7
Unemployed	15.7	15.4
Other inactive	16.0	21.5

the average. In the Bodrogköz region it was mostly pensioners, those of primary education, people above 50 and of low-medium income who indicated having lasting health damage. In Bereg as well as in Bodrogköz the relationship between health status and health damage was significantly correlated.

Another potential factor of vulnerability is the *capacity to cope with problems,* which we explored with a question that elicited coping strategies of those who experienced a flood. In both regions, a typical response for coping was to try to analyze and understand the situation, especially among the younger people (40–49) and those considering themselves as less exposed. In Bereg a typical coping strategy was to take a positive attitude or interpretation of the problems faced. In Bodrogköz, a frequent response was coping through positive personal change or "emerging as a different person", combined with creative activity. Taking sedatives and medicines, as well as self-destructive activities, were characteristic only to a small extent, but more in Bodrogköz than in Bereg and more by those considering themselves to be less healthy.

11.3.4 Education

The proportion of respondents having completed not more than 8 classes of primary school was 59% in Bereg and 47% in the Bodrogköz region. In Bereg 21% and in Bodrogköz 31% of the respondents held certificates from a vocational secondary school. The proportion of those who had passed their grammar secondary final certificate was 14 and 18%, respectively, whereas the proportion of those who had university degrees was 5 and 4%, respectively.

11.3.5 Household Economic Data

As far as *employment status* is concerned the survey responses are reported in Table 11.4.

The proportion of active earners is lower in both regions than the national average (58%), and unemployment is more than double the national average (7.5%). Responses to questions on *household incomes* follow a similar pattern, except the proportion of medium incomes (HUF 91–120,000) and high income (above HUF 121,000) are somewhat higher in Bereg (28 and 30%) compared to 25 and 26% in Bodrogköz.

Table 11.5 Reported forms of savings (%)

	Bereg	Bodrogköz
In real estate	2.3	7.9
Other assets	11.0	10.8
At home in cash	19.7	12.8
In savings books and savings accounts	22.0	20.1
In life-, pension – or health insurance funds	16.7	14.1

Table 11.6 Reported forms of borrowing options (small and large)

	Small amount		Large amount	
Borrowed from	Bereg	Bodr.	Bereg	Bodr.
Immediate family members	74.7	62.6	13.0	10.3
Relative living in the same settlement	33.3	32.4	5.3	6.9
Distant relative	13.3	9.0	1.3	2.2
Acquaintance, neighbor, or associate at work	22.3	16.3	2.7	1.8
Bank or credit institution	41.0	20.6	27.3	21.4

Savings can enable households to recover from floods and thus represent an important factor reducing vulnerability and building coping capacity. Table 11.5 shows the types of reported savings.

Not surprising, those with primary education, the unemployed and other inactive persons are overrepresented among those not having savings, which in Bereg was 66% of the population and in Bodrogköz 57%. In the Bodrogköz region, people living in exposed regions mentioned real estate and other assets as forms of savings in larger proportions than those in Bereg, whereas cash at home and savings accounts were mostly characteristic of pensioners. It is active earners, people with grammar, secondary school, and university degrees as well as people between 30 and 39 years of age, who invest in insurance.

As in the case with savings also borrowing capabilities can enable households to recover from floods and thus also represent an important factor. Table 11.6 reports findings on who respondents borrowed from, dependent on the amount.

In Bereg the possibilities of taking loans were assessed as better in every category than in the Bodrogköz region. Generally speaking the possibility of getting loans from close relatives and acquaintances occurred in greater proportion in the case of smaller sums only, whereas distant relatives did not figure significantly either in the case of smaller or of significant sums. It was active earners, those with grammar secondary education and university degree who mentioned the various possibilities of taking loans above the average. In Bereg active earners and people of at least secondary education were those who had outstanding proportions among those capable of receiving smaller loans. In addition to those groups it was mostly people of medium- and high household income and those between 40 and 49 years of age who were capable of getting bigger loans.

Table 11.7 Trust in members of the community (averages of a 100-grade scale)

Trust in	Bereg	Bodrogköz
People living in the neighborhood	36	39
More distant acquaintances	40	40
People of workplace	45	45

11.3.6 Social Capital

Trust can be an important indicator of social capital (Newton 2001). We measured (i) trust in members of the close community (neighbors, acquaintances, associates at work) and (ii) trust in public institutions. A strikingly low level of trust was found in community members and public institutions in both regions (Table 11.7).

In the Bereg region, active earners were overrepresented among those who trusted members of the community, whereas pensioners, the unemployed and those of the lowest income were over-represented among the mistrustful. In the Bodrogköz region trust-related responses do not offer as uniform of a picture as in Bereg. Active earners trusted most their neighbors; pensioners trusted most their more distant acquaintances, whereas active earners, men, those of vocational secondary education and people of the highest income had greatest trust in their associates at work. The unemployed, other inactive people, as well as low-medium income people were more mistrustful of their neighbors. People between 18 and 29 years of age as well as the unemployed were mistrustful of more distant acquaintances. Women, people of primary education as well as low- and medium-income were less trustful of their associates at work.

The most trusted institutions in both regions were the schools, police, water management authorities and water associations. The credibility of the national government was regarded the lowest in both areas. Considering the socio-demographic variables, the younger age groups, the less qualified and those of lower incomes, as well as inactive people, reported less trust in public institutions than the average. The main difference between the two regions is that opinions related to credibility are divided by age and income in the Bodrogköz region, whereas they are divided more by school education in the Bereg region. Economic activity is a significant factor in both regions.

We explored the *social relations* of respondents by asking *how many family members and relatives lived in the given settlement or region*. The average number of family members and relatives living in the same settlement was 22 in Bereg and 21 in Bodrogköz, i.e., large families are still typical in both regions.

We measured *social isolation* by asking how much the respondent agreed to the following statement: "I frequently feel myself lonely." In Bereg 26% of respondents reported that this statement was fully or partly true, whereas this proportion was 24% in the Bodrogköz region. These figures are surprisingly high, considering the traditionally strong ties within extended families and among neighbors in small villages. In Bereg, women and pensioners were in the greatest proportion among those who feel entirely or partially lonely, whereas in the Bodrogköz region they were joined by those with low incomes and only primary

Table 11.8 Have you ever tried to contact the local government about an issue that affected you? (%)

	Bereg	Bodrogköz
Yes, once	9.4	9.2
Yes, several times	13.7	17.7
No	76.9	73.1

Table 11.9 Types of flood damages suffered since 1998 among those who experienced floods (%)

Type of damage	Bereg	Bodrogköz
Settlement of residence	81	42
Residential home or flat	77	38
Respondent (and family) evacuated	74	9
Relatives	71	29
Agricultural buildings (e.g., pen, stable)	57	22
Furnishings	49	19
Crops, arable land, vineyard, orchard	39	37
Stock and harvested grain	28	7
Savings reduced	23	16
Absence from work, loss of salary and income	13	4
Illness generated or renewed	6	7

education. The extent of loneliness shows negative correlation with the number of relatives in the settlement and region in Bereg as well as in the Bodrogköz region.

We measured the *civic activities* of respondents by the question whether the *interviewee had contacted the local government about* an issue affecting him or her. The results are given in Table 11.8.

In the Bodrogköz region it was people in the 50–59 year age group and those of low to medium income who were over represented among the most active. In Bereg most frequently those between 30 and 39 years of age, diploma-holders and the unemployed had contacted the local government.

Our results indicate low-trust and fragmented communities, with highly limited civic activities. It is not different from the overall Hungarian picture, where the socio-economic transition of 1990 has deepened social inequalities and broken up former solidarities without creating a strong new civil society (Utasi 2006).

11.3.7 The Impacts of Floods

We measured the negative impacts of floods (losses, damages, indirect effects), their gravity and duration by several questions addressed to those who had experienced floods. From Table 11.9 it can be seen that there was a significant difference between the two regions with respect to flood damages. In Bereg the overwhelming majority of the population suffered some kind of damage, whereas that proportion was around one third in the Bodrogköz region. As far as material damages are concerned, in both regions residential property, agricultural buildings, furnishings of the home, as well as crops, arable land, vineyards and orchards suffered damages most frequently.

Table 11.10 Assessment of the durability of flood impacts among those who experienced floods (%)

Duration	Bereg	Bodrogköz
3 months	15	27
6 months	16	35
1 year	47	20
Still can be felt	20	16
"There was no flood"	2	2

Studying the relationships between damages, exposure, and socio-economic variables revealed some insights related to vulnerability. In Bereg, those who suffered the most damages to their homes and agricultural buildings were not only those most exposed, but there was a correlation with respondents reporting low trust in local institutions, limited savings, and limited access to even small sums of loan. In the Bodrogköz region, the correlations were similar with the exception that those most affected also considered themselves to be less prepared. In both regions, floods appeared to impose more losses on those in poor health. The largest difference between the two regions was the number of those experiencing evacuations – 9% in the Bodrogköz region compared to 75% in Bereg. Those evacuated appeared to be disproportionally in the group who were mistrustful of members of the community and public institutions, had no savings and could not obtain small loans.

Another question, reported in Table 11.10, asked *about the duration of the physical impact of the floods*. The perception of duration appears to be shorter in Bodrogköz, although it is striking that around one-fifth of those experiencing floods in the past feel that the impacts have continued to the present.

In the Bereg region this response was related to trust. Those who perceived the effects of floods for a shorter time were those who trusted their neighbors, acquaintances and associates at work, and felt most public institutions were credible.

According to the above analysis the two investigated flood basins significantly differ in terms of exposure, i.e., in Bereg a much higher proportion of homes is exposed to floods than in Bodrogköz, and similarly, a much higher proportion of the inhabitants have already experienced flooding and suffered damages. In terms of socio-economic characteristics differences between the two areas are smaller. Concerning the level of health, education, and savings the situation is somewhat better in Bodrogköz than in Bereg, whereas the ratio of active earners, the magnitude of household incomes and the opportunities for taking loans are somewhat more favorable in Bereg. More importantly, however, both regions are strongly handicapped if compared with the national average, especially in terms of qualification and economic activity.

11.4 Vulnerability Indicators

After the detailed presentation and comparison of the vulnerability and exposure variables for the two regions, we now turn to the question of what variables or sets of variables can explain best the responses on impact. As shown in Fig. 11.1 we will

Table 11.11 Selected impact (damages and indirect effects) variables

Variables	Abbreviation
Damages in residential property and/or in its contents	D1
Agricultural damages (damages to agricultural buildings, crops, harvest stock)	D2
Loss of income	D3
Evacuation and/or health damage	D4
Duration of impacts	D5

Table 11.12 Vulnerability variables selected on the basis of principle component and correlation analysis

Variables	Abbreviation
Health status	V1
School education	V2
Economic activity	V3
Household income	V4
Having any form of savings	V5
Possibility of getting a small loan	V6
Possibility of getting a large loan	V7
Trust in members of the community	V8
Assessment of the credibility of institutions	V9
Assessment of past preparedness	V10
Assessment of future preparedness	V11

treat impacts as a function of exposure and vulnerability. This assumption seems to be valid as exploratory bivariate correlation analyses have shown that most impacts are related to perceived flood exposure, *and* to most of the hypothesized vulnerability variables, while keeping exposure constant. To identify factors, i.e. sets of variables representing a latent construct, not measurable with a single variable, we first applied principle component analysis[6] of impacts by creating these variables first (see Table 11.11) and afterwards looked at the vulnerability and exposure variables which show significant correlation:

The exposure variable was chosen to be the respondents' exposure (a combination of the settlement' exposure and the home's exposure variables, called E1). The following vulnerability variables were selected based on (i) significant correlation to damages, and (ii) those which carry the largest information content within the given group of variables. Table 11.12 shows the results. Some interrelationships and important differences between the two regions were identified among the above variables. In Bereg significant relations exist among the V1–V7 variables. In Bodrogköz significant relations were found among the V3–V8 variables, and V1 is also correlated with variables V3, V4, V5 and V7. In Bereg the V8–V11 indices of trust and preparedness show correlation with each other, whereas in Bodrogköz they show close correlation rather with members of the V1–V8 group. There are significant connections between respondent's exposure (E1) and certain indicators

[6] Some variables were transformed in advance, for instance we have transformed variables measured on scales of four and five grades into a 100-grade scale.

Table 11.13 Latent factors, number of variables and Cronbachs alpha[a]

Index (Abbreviation)	Number of variables	Cronbachs Alpha
Impact Factor (IdF)	11	0.842
Preparedness Institutions Factor (VprepF)	4	0.946
Savings Factor (VsavF)	5	0.955
Borrowing Factor (VborF)	10	0.736

[a]For example, the impact factor (IdF) is now a continuous variable which is basically, for each observation, the sum of the responses to the 11 impact questions coded as 0 or 1 (no or yes). Hence, the higher the number of IdF the higher the (negative) impact The other factors were formed in a similar way: the Preparedness Institutions Factor (VprepF) is the sum of the responses to the 4 questions associated with the past preparedness of the various institutions, the Savings Factor (VsavF) is the sum of 5 responses on savings, and the Borrowing Factor (VborF) is the sum of 10 responses on the borrowing possibilities. Also, instead of the dichotomous exposure variable E1 we used the Exposure variable based on the respondent's self-evaluation of exposure to floods, which had three possible values, including 'strong', 'weak' and 'no' exposure

of vulnerability (V1, V4 in Bereg, V2, V3 and V6 in Bodrogköz). The socio-economic status of those exposed is somewhat worse; there are greater proportions of less healthy, less qualified and less active people among them. This suggests that socially disadvantaged groups live in larger proportions in high risk areas. Respondent's exposure (E1) shows significant correlation with most indicators standing for impacts (D1–D5) in both regions. All the vulnerability indicators (V1–V11) show significant correlation to the variables indicating impacts (D1–D5) (even if the effects of exposure are screened), at least in one region.

The above analysis indicates that there are strong relations among various vulnerability indicators, as well as between variables of exposure, vulnerability and impacts. In order to further analyze these relationships, latent factors based on the results above are constructed. However, we re-assessed the reliability of the scales too. Afterwards, we determined the set of variables for each of the factors by choosing only those variables from each set that returned the highest reliabilities (using Cronbachs Alpha). The factors that have been built with this procedure are listed in Table 11.13.

Using the new factors, as well as the other vulnerabilities explained in detail in the previous section, we proceeded with multivariate tests and analyses. As Fig. 11.2 indicates, it is evident that the "Area" variable (Bereg or Bodrogköz), as well as the "Exposure" variable have a dominant role for the impact factor IdF (Fig. 11.2).

The box plot shows that IdF for each exposure sub-group is higher for the Bereg area.[7] Furthermore, one can see that for decreasing exposure there is a decrease in the IdF irrespective of the Area variable. Differences between the IdF and the Area variable, as well as the Exposure variable, are highly significant (a non-parametric

[7] Which can be seen, for example, by the thick black line in each box plot which represents the median.

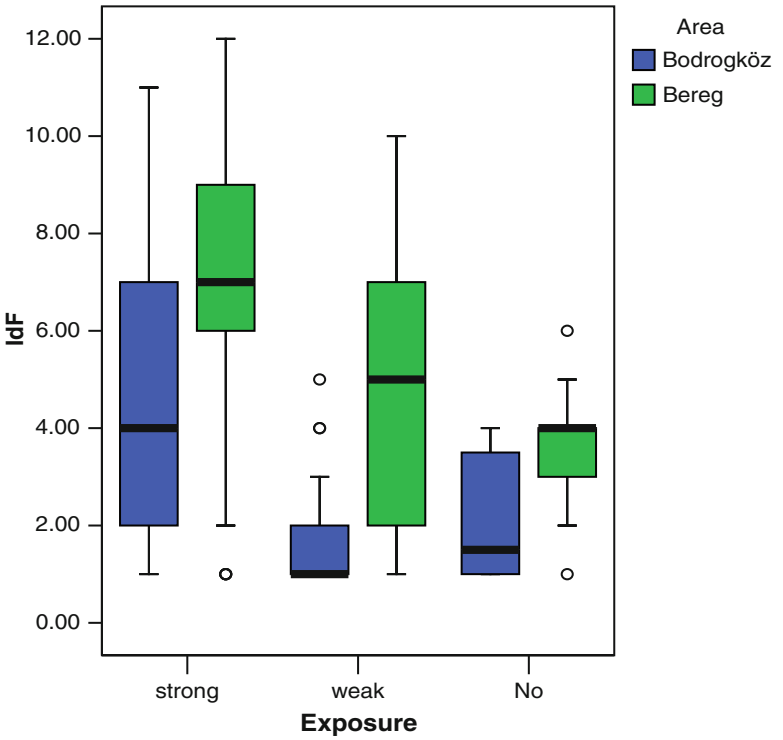

Fig. 11.2 *Box* plots of the impact factor separated according to area and exposure

Mann Whitney-U test was used). However, this is not the case for the interactions between the two variables and IdF, i.e. Area and Exposure together does not show significantly different IdF.

As a next step, to incorporate interactions between the vulnerability and exposure variables as well as the latent factors, a general linear model approach was used.[8] In more detail, a general linear model with two factors (Exposure and Area), as well as the corresponding vulnerability covariates, was created and tested. Interrelationships up to the third level were also enabled. The model was significant with an R-square of 0.699. Significant variables included the exposure and area variables, trust, education, borrowing capacity, savings, health and perception of (past) institutional preparedness. In a next step the sample was analyzed by means of dummy variables again using a general regression model, but now without the factors, but keeping interactions possible up to the second level. For example, we looked at each Exposure and Area sub-group and performed a regression analysis.

[8] Here, combinations of factors (dichotomous variables) and covariates (continuous variables or factors) can be studied in more detail. Usually, continuous independent variables are called covariates an dichotomous independent variables are called factors in general linear models. Hence, we use these terms in the following.

Table 11.14 Vulnerability variables derived from regression analysis

Variables	Abbreviation
Health status	V1
School education	V2
Savings Factor	VsavF
Borrowing Factor	VborF
Trust in members of the community	V8
Social relations	V12
Preparedness Institutions Factor	VprepF

For Bodrogköz (medium exposure) no significant variables were found. Reasons for that could be the small number of observations, as well as a small spread of the IdF variable. For Bereg (high exposure) significant variables included education, savings level, borrowing capacity, trust, social relations (i.e., number of family members in the region), and civic activity.

As regards the relationships between vulnerability variables and impacts, savings and borrowing abilities (and both together) are important, e.g. the higher the capacities, the lower the impacts, however, correlations are low. Not surprisingly, perception of good self preparedness in the past correlates with lower impacts, and to the contrary, bad perception of the preparedness of the responsible institutions correlates with high impacts. Also, with higher social relationships within the community, impacts decrease. Alternatively, stronger civic activity shows higher impacts, which could be explained in the sense that those who suffer large losses have more motivation to complain to the authorities, which would then mean that civic activity should be regarded as an exposure variable. Vulnerability indicators drawn from the above analysis are summarized in Table 11.14.

The importance of the variables differ dependent on exposure level. Especially health status and education are important vulnerability indicators for middle exposed households, while for highly exposed households, savings, borrowing, trust, and social relations are more important as indicators for vulnerability. Trust and perception of preparedness of institutions are overall indicators of vulnerability (but with lower correlations).

11.5 Conclusions and Recommendations

The primary aim of the chapter was to determine the major socio-economic factors of flood vulnerability in regions highly exposed to floods. As it was expected, the most important single variable determining impacts was the level of exposure and geographical location. Most important indicators of social vulnerability proved to be the following: health, education, savings, opportunities of taking loans, trust in the members of the community and institutions, social relations, and perception of preparedness of institutions against flood events. Remarkably, the majority of indicators are related to human and social capital, as well as institutional capacities. Economic variables, including income and employment appear less significant, which may partially be the result of the low reliability of such data.

We found that the situation of the population of the Upper Tisza regions is rather diverse regarding vulnerability. Only 40–50% of the population assesses their health status as being good; only 40–55% have completed more than primary education; only 35–45% have savings; and less than 35% would have access to large loans. Trust is rather low and people assessed their flood preparedness as slightly higher than mediocre. On the basis of the survey, it is possible to identify the most vulnerable groups that are in a disadvantageous position, due to their health and education status, as well as economic strength and social relations. Hence, these indicators seem to be valid for determining the social vulnerability due to floods.

This research goes beyond the study of the vulnerability of the regions in question. Based on the indicators identified and the questionnaire created for their measurement it may be expedient to assess the vulnerability of populations in other high flood risk areas of Hungary and to identify the particularly vulnerable groups. From a policy perspective, it seems worthwhile to further identify options for reducing the level of exposure, either by structural or non-structural mitigation measures. In addition, there are various opportunities to increase the resilience of exposed communities. For example, increasing public spending on education would increase the resilience of households in the future. Strengthening social cohesion would most likely be an effective intervention. From a disaster risk financing strategy, limited options remain for the government to directly help people at the household level. However, there are large opportunities to help the population help themselves in the future, for example, by introducing contingency loans so that borrowing is also feasible for poorer communities and by establishing public/private insurance arrangements that are both feasible and attractive for property owners. Creating incentives to increase informal strategies to lessen the short term (and therefore also the long term) consequences of the disaster event, such as providing information on what should be done in case of floods (e.g. safe meeting places for inhabitants, as well as for volunteers) and providing timely information on where to apply for financial support would also increase the resilience of exposed communities.

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