

## Household flood risk reduction in the Czech Republic

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**Abstract** This paper uses household surveys in the Bečva River Basin, the Czech Republic to determine the coping and adaptation measures that are implemented for flood risk reduction. In 2012, door-to-door surveys with household residents ( $N=304$ ) were completed in areas of high, low, and ostensibly no flood risk. Using a probit model as a regression technique through the statistical software STATA, we explored factors that potentially influence coping and adaptation. Overall, coping and adaptation measures for flooding were not undertaken extensively and the rate of change to adopt measures was slow, even amongst flood-affected households. More work is needed to understand the reasons behind their reticence, especially to confirm how much financial factors are a limiting agent. The regression analysis indicated that more children and more men in the household supported the adoption of adaptation measures. As well, when people perceive that they live in a low or high flood risk zone, the likelihood of taking some adaptation measurements increases compared with the perception of living in a no flood risk zone. Meanwhile, the highest negative correlation was that living in a house elevated off the ground decreases the likelihood of taking other adaptation measurements by 20 %.

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## 1 Introduction

This paper focuses on societal coping and adaptation to river flood risk in Central Europe at the household level. Using the case study of the Bečva River in the Czech Republic, this study aims to determine household coping and adaptation measures to reduce flood risk and the household's reasons for choosing these measures. The Czech Republic is of particular interest in the European context due to the several, recent flooding disasters which were national emergencies, including in 1997, 2002, 2006, 2010, and 2013, as well as due to the few previous studies available on Czech perceptions and actions regarding river flood risk. This paper contributes to filling that gap by presenting empirical evidence for the links amongst characteristics of households in river flood risk zones, the river flood experiences and perceptions of people in those households, and the form of coping and adaptation measures (Table 1) which they adopt.

## 2 Methods

In the case study area, we chose twelve villages located along the Roznovska Bečva River and the Bečva River, with the former being a main tributary of the latter. The main criteria for selecting locations was equal distribution amongst no-, low-, and high-risk zones according to the Czech national system of designating flood risk areas. For major rivers,

**Table 1** Potential household coping and adaptation measures in the Becva River basin

Theme	Coping strategies	Adaptation strategies
Planning and construction	Changing floor material on the ground floor to be water-resistant. Installing mobile window and door flood barriers.	Not building in flood-prone areas. Elevating the ground floor (at least 1 m) or having garages or simple basements/cellars as the ground floor. Using water-resistant materials and finishes. Designing and constructing to withstand flood forces. Implementing hydro-isolation of the walls to avoid water contact in inundated ground. Installing more complex water drainage systems around the house and terrain adjustments such as earthworks, ditches, or retention basins.
Insurance	Purchasing contents and property insurance for environmental hazards.	
Information	Using information from local forecasting and warning systems.	Having household meteorological and hydrological stations.
Preparedness	Having and testing a household evacuation plan under different scenarios. Keeping valuables on upper stories.	

Sources include Begum et al. (2007), Haque et al. (2012), Kreibich et al. (2005, 2011), and Szöllösi-Nagy and Zevenbergen (2005)

maps and data are publically available from the Czech authority DIBAVOD (Digital Water Management Information) based on Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 (the Water Framework Directive) as incorporated into the Czech Water Act No. 254/2001. The main criteria for selecting households within each flood risk zone were permanent residence on-site and ownership of a family house to ensure that the property occupiers are responsible for the property condition.

We conducted a door-to-door questionnaire ( $N=304$ ) in 2012, mixing closed and open-ended questions, to survey household representatives with regards to their household coping with and adaptation to river flood risk. All houses within the high risk and low risk flood zones were visited. Across all three zones, an estimated 110 households never answered their door, despite repeated visits, while approximately 40 households answered, but declined to participate. The surveys were conducted in Czech by Czech native speakers who filled out the questionnaire form while speaking with the household members. Each survey lasted between 30 and 60 min.

For defining flood risk zones, DIBAVOD calculates the return period of a watercourse's peak discharge rate. High risk zones are defined by the inundation extent of the 20-year return period, low-risk flood zones are between a 20- and 100-year return period, and no-risk zones are outside the 100-year return period. No location truly has zero flood risk, but no-risk is the formal designation in the Czech Republic for areas outside the 100-year return period, so we use that phrase.

While this method is used for big rivers, such as the Bečva River, we also need the risk zones for smaller watercourses. We extended the risk zones to smaller watercourses in the villages studied through consultations with local experts, respondents' experience with small floods, and any local data available. We then generally identified high-risk zones as households affected by repeatedly devastating floods over the past 15 years; low-risk zones as households affected to a lesser degree and sometimes indirectly due to water table rise; and no-risk zones as the remainder.

Based on previous studies (e.g. Begum et al. 2007; Botzen et al. 2013; Kreibich et al. 2005, 2011; Weber 2010) and local conditions in the case study area, our questionnaire covered:

- Household characteristics, including household members' ages, education levels, incomes, and family structures.
- Flood experiences, including timing, frequency, level of impact, and damage.
- Coping and adaptation measures adopted including economic aspects of households selecting measures.
- Flood risk preparedness, awareness, and perception, including forecasting and warning information sources, use of those sources, perception of local quality of life, and perception of flood risk reduction measures and systems.

### 3 Results

#### 3.1 Questionnaire responses

Out of the 304 households surveyed, 72 % (220) of households had experienced floods (corresponding with the actual high- and low-risk flood zones). Concerning repeated flooding, 36 % (109) of the surveyed households had experienced one flood, 28 % (86) had experienced two floods, and 8 % (25) had experienced at least three floods (the remaining households had not experienced flooding).

Out of all households surveyed, 75 % (227) were located on flat land, 22 % (67) on moderate slopes, and 3 % (10) on steep slopes. 78 % (236) have a cellar. Houses are constructed of various building materials: 67 % (203) from fired bricks and 19 % (57) from either non-fired bricks or a combination of fired and non-fired bricks. The other 14 % (44) of houses are constructed from other materials, such as timber or breeze blocks. 7 % (20) of houses have a stone basement which is an old, traditional flood adaptation measure because it is easy to clean after flood waters have receded. However, there are now modern dangers in the form of pesticides, fertilisers, and chemicals which often contaminate flood waters and leave a harmful residue afterwards.

Approximately half of the houses have a ground floor up to 1 m above the ground level while 30 % (91) have an elevated ground floor higher than 1 m. In comparing the age of the houses with their ground floor elevation, the proportion of houses with elevated ground floors has substantially decreased over the past 20 years after peaking during Communist times, despite the frequent flooding. Moreover, the proportion of houses with elevated ground floors is similar for all risk zones. The developers and owners of new houses are following the fashionable or lower-cost choices of houses which are not raised, despite the flood risk.

Czech legislation recommends, rather than demands, that building authorities elevate the ground floor for new houses in the low flood risk zones. Current water legislation regulations included in the Czech Water Act No. 254/2001 forbid new houses in high risk zones. In practice, monitoring and enforcement are not strict—especially when political and development interests simply delay implementation.

The share of households which has purchased insurance for environmental hazards has gradually increased up to 95 % in 2010. Yet a few respondents claimed that they could not obtain insurance, because the insurance companies refused to sell it to them or offered high premiums, claiming that the occurrence of floods in their area is more of a trend than of random events. One household gave up trying to restore their damaged ground floor and moved upstairs permanently. Even those with insurance claimed that they usually did not receive enough of a pay-out to cover their financial losses.

Overall, the adaptation measures adopted were limited. 59 % of households adopted one measure, 27 % adopted two measures, 11 % adopted three measures, and 4 % adopted four measures. A pattern did emerge that, the higher the flood risk zone in which a house sits, the more adaptation measures the household tends to take.

### 3.2 Regression

For more quantitative analysis, we used a probit model as a regression technique through the statistical software STATA to investigate of the link amongst various factors and the probability of household adaptation measures being applied. We model the decision tree for regression as YES/NO for taking any flood risk reduction measure. If the decision is YES, then we distinguish between coping and adaptation measures. Coping measures showed limited results, so we focus on the selection (probit) equation for adaptation.

Amongst the individual household characteristics, the most significant correlations were found for gender, number of children, and number of people in a household. Having more children or more males in the household tended to lead to more adaptation measures being adopted. The presence of one more man increased the number of adaptation measures by nearly 25 %.

Owning an elevated house decreased the adoption of other adaptation measures by 20 %. It is likely that households felt that elevation would be sufficient for flood risk reduction, so further action would not be needed. Yet according to the regression, experience did not

influence adaptation measures adopted. The small positive correlation between the total number of floods experienced and adaptation measures adopted was not statistically significant, which was the same case when checking total flood financial losses.

Also for financial variables, regarding share, the more financial resources required for post-flood property rehabilitation or reconstruction, the less adaptation measures that were adopted. This result is likely because people have a fixed budget for post-flood reconstruction, such as a pay-out from insurance or loans. Basic reinstatement of a liveable house must be completed, but if flood resilient measures cost more or are assumed to cost more, then the opportunity might not exist for spending on, or investigating the costs of, adaptation measures. The need to invest one's own resources into post-flood reconstruction was confirmed by the questionnaire. Even if a household had insurance, it generally contributed to the reconstruction costs, with respondents stating that, on average, they contributed 39 %.

Perceptions of the flood risk zone in which a household sits influence adaptation measures taken. Households perceiving that they are in low or high flood risk zones, when compared with perceiving to be in a no-risk zone, saw the likelihood of taking an adaptation measurement rise by 19 % and 24 % respectively.

But perception might not be the same as reality with regards to flood risk. When we compared the actual flood risk zone in which a house sits with the household's perception of the zone which they inhabit, risk underestimation was prominent for the Bečva River Basin. Many more people thought that they lived in a no-risk zone than actually live there, meaning that those in low- and high-risk zones did not perceive their flood risk to be so high. Rather than ignorance of the flood risk, given their past experiences, the most likely explanation is people are used to living with floods and perceive them to be less serious than less frequently manifesting risks. In fact, one household member commented, "I do not suffer from floods. I just have my garden and cellar flooded every year."

#### 4 Conclusion

This paper presented household surveys in the Bečva River Basin, the Czech Republic to determine the coping and adaptation measures that the households implement for flood risk reduction and the reasons why they choose these measures. Overall, households appear to be reluctant to undertake extensive adaptation measures, suggesting that more work is needed to understand the reasons behind their reticence, especially to confirm how much financial factors are a limiting agent. An important lesson is that flood damage could be reduced with subsidies for flood risk reduction measures—but subsidies would not assist with promoting all potential measures.

The regression analysis provides further lessons regarding factors which enhance or decrease the likelihood of adopting coping and adaptation measures. In particular, the number of children, gender composition in the household, and perception of flood risk stood out from the regression. Further investigation of these factors and why, not just how, they influence household choices would be a useful strategy for developing tools to evaluate household ability and responsibility regarding flood risk reduction.

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