



# The determinants of households' flood mitigation decisions in France - on the possibility of feedback effects from past investments



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## ABSTRACT

In this paper, we investigate the determinants of private flood mitigation in France. We conducted a survey among 331 inhabitants of two flood-prone areas and collected data on several topics, including individual flood mitigation, risk perception, risk experience, and sociodemographic characteristics. We estimate discrete choice models to explain either the precautionary measures taken by the household, or the intention to undertake such measures in the future. Our results confirm that the Protection Motivation Theory is a relevant framework to describe the mechanisms of private flood mitigation in France, highlighting in particular the importance of threat appraisal and previous experience of floods. Some sociodemographic features also play a significant role in explaining private flood mitigation. We also observed that respondents who had already taken precautionary measures have a lower perception of the risk of flooding than respondents who planned to implement such measures at the time of the survey. This result can be explained by the existence of a feedback effect of having taken precautionary measures on risk perception. If subsequent studies support this assumption, it would imply that intended measures, rather than implemented ones, should be examined to explore further the determinants of private flood mitigation.

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## 1. Introduction

In 2014, floods accounted for more than a third of the total estimated damage caused by natural disasters worldwide, which amounted to 100 billion US dollar.<sup>1</sup> Thus, they are already a major source of concern. In addition, the frequency and magnitude of extreme events such as floods are expected to be modified due to climate change (Patwardhan et al., 2007). As a result, adaptation to natural disasters, and in particular to floods, is one of the key challenges humans will have to face to build and maintain sustainable societies. France is very affected by floods, whose annual cost is over one billion Euros (OECD, 2014), and one in four inhabitants is exposed to this risk (DGPR, 2011).<sup>2</sup> Yet so far, very few studies have investigated flood prevention measures in France (Poussin et al., 2014, 2015).

The measures aimed at protecting people from flood risks or mitigating their negative consequences can be classified as public or private actions. Among public responses are zoning policies, solidarity and compensation schemes, and collective protection measures, like dykes or flood retention basins (Erdlenbruch et al., 2009; Picard, 2008). On the other hand, individuals themselves can take actions. In many countries, they can subscribe to private insurances aimed at compensating monetary losses after a natural disaster. In France, since there is a compulsory national compensation system (Catnat), individuals do not take the decision to buy an insurance or not, but they can decide to take precautionary measures aimed at mitigating the consequences of floods in their home, such as installing pumps or watertight doors and windows. This can be seen as an auto-insurance (Carson et al., 2013).

Several points can be raised to underline the paramount importance of private precautionary measures for the sustainability of socio-ecological systems. First, large structural flood defenses such as dams, storage reservoirs and embankments lack reversibility and can provide a misleading feeling of complete safety among populations exposed to floods (Kundzewicz, 1999). For this reason, they may hinder adaptation to changing risks of flooding. Moreover, they can harm ecosystems (Werritty, 2006). Conversely, since private

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<sup>1</sup> [http://www.emdat.be/disaster\\_trends/index.html](http://www.emdat.be/disaster_trends/index.html)

<sup>2</sup> This figure was estimated by taking into account all the population living within the limits of areas potentially affected by extreme flood events (more than 100-year flood events).

precautionary measures are more local and can be designed for the specific situation and exposure of a household, they may be more flexible and have less impact on the environment than public flood defenses. Moreover, by implementing precautionary measures, individuals take responsibility for their own safety. Hence, the use of such measures can help maintain a certain awareness of the risk of flooding among exposed populations. Finally, several studies suggest that individual precautionary measures have great potential to reduce the consequences of natural disasters. For instance, Poussin et al. (2015) showed that elevating buildings could reduce the ratio of total damage to total building values by 48% in three different areas in France. Similar results have been obtained in Germany (Kreibich et al., 2005) and in the Netherlands (Botzen et al., 2009).

This paper recognizes the importance of private initiatives and investigates the mechanisms at stake when people decide whether to take precautionary measures or not. We combine economic approaches, stressing the importance of individual decision making in investing in self-insurance for their properties (Carson et al., 2013) and psychological approaches, highlighting the importance of perceptions and emotions to explain people's motivations to take actions in order to reduce their risk vulnerability (Rogers, 1975).

Several studies on individual flood preparedness have identified the Protection Motivation Theory as a relevant framework to explain the implementation of precautionary measures (Grothmann and Reusswig, 2006; Poussin et al., 2014; Reynaud et al., 2013). However, in spite of the overall adequacy of this framework, and as highlighted by Bubeck et al. (2012), most studies are cross-sectional and may thus neglect possible feedback effects from already adopted precautionary measures on explanatory factors.

This article thus has two main objectives: i) to test the relevance of the Protection Motivation Theory in France, and if necessary to expand its framework by including the effects of socio-demographic variables, and ii) to investigate whether past decisions have an impact on people's perceptions and intentions, and how these feedback effects in turn affect the robustness of the Protection Motivation Theory.

To examine these questions, we conducted a survey among households in flood prone areas in the South of France, that have been hit by major floods at different points in time during the last 20 years. We collected data on exposure, attitudes, risk perception, experience of floods, characteristics of housing, and socio-demographic features from 331 households. We explored possible feedback effects by asking the respondents not only to indicate which precautionary measures they took, but also which ones they considered implementing at the time of the survey. We used discrete choice decisions models (Train, 2009) to compare the adequacy of the Protection Motivation Theory to explain implemented and planned measures and compared the perceptions and emotions of people who had already taken measures with those of respondents who still considered taking actions in the future.

In line with the existing literature, we confirm the relevance of the Protection Motivation Theory to explain private flood mitigation. Our results highlight the importance of threat appraisal, threat experience appraisal and, to a lesser extent, coping appraisal. In addition, we provide evidence for a feedback effect of the implementation of precautionary measures on risk perceptions.

In Section 2, we explain the Protection Motivation Theory and its strengths and weaknesses. In Section 3, we present the survey designed to investigate the drivers of private flood mitigation and the data we collected and then explain how we statistically analysed this information. We present our results in Section 4 before discussing them in Section 5. Finally, in Section 6 we present our conclusion.

## 2. Literature on Protection Motivation Theory

The Protection Motivation Theory was first proposed by Rogers (1975) and applied in the health domain. It was further developed by Milne et al. (2000) and adapted to the context of floods by Grothmann and Reusswig (2006). According to this framework and as presented in Fig. 1, the higher an individual's appraisal of the threat of flooding, the more likely he/she will respond to this risk by adopting either non-protective responses, such as a fatalist position, or by taking precautionary measures. The individual's coping appraisal will influence the type of response: the more a person thinks that he/she is able to protect him/herself against the consequences of floods, the more he/she will tend to take precautionary measures rather than a non-protective response. People who have already experienced a flood would be expected to be all the more likely to take precautionary actions that the event that affected them was severe. On the other hand, reliance on public flood protection and actual barriers, such as a lack of monetary resources, would be expected to negatively affect the implementation of precautionary measures.

The Protection Motivation Theory has been successfully applied to explain private flood mitigation in several countries (Glenk and Fischer, 2010; Grothmann and Reusswig, 2006; Poussin et al., 2014; Reynaud et al., 2013). Thus, it appears to be quite robust and flexible. However, since most studies are cross-sectional, they examine the links between perceptions, emotions, and flood mitigation at one point in time. As a result, they may ignore possible feedback effects from precautionary measures that have already been taken (Bubeck et al., 2012).

## 3. Method

### 3.1. Sample

Fig. 2 shows the geographical location of the two departments surveyed: the Aude department and the Var department. Both departments are subject to flash floods. The Aude department was severely impacted by such a phenomenon in November 1999. Thirty-five people died and it caused an estimated loss of 771 million euros (Vinet, 2008). The Var department was hit by a major flash flood in June 2010 that killed 26 people. The estimated damage due to this disaster was between 1000 and 1500 million euros (Vinet et al., 2012). The respondents were selected so that approximately 80% of the sample had already experienced at least one flood and lived in municipalities

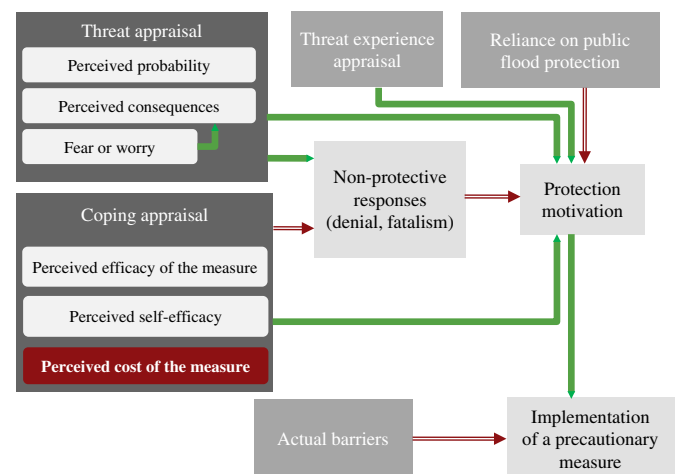


Fig. 1. The Protection Motivation Theory. Source: adapted from Grothmann and Reusswig (2006)

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