

Impact of societal memory on the efficiency of flood early warning systems

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INTRODUCTION

The concept of flood management has evolved from being a set of strictly technical procedures to integrating all relevant actions and actors in flood crisis situations (Basher 2006). However, most flood management operations and research are still constrained by the limited understanding of the interactions and feedbacks between the physical and social systems during flood situations (Di Baldassarre et al. 2013). This is beginning to change as both researchers and practitioners are realizing the importance of integrating social, environmental, and economic aspects of flood risk management (Buchecker et al. 2013). One key aspect of successful flood risk management is understanding the behaviour of the public as it contributes to taking full advantage of the available technological capabilities as well as to reducing the casualties from flooding events (Parker et al. 2009). When facing natural disasters, people's behaviour is largely determined by their awareness of the risks involved. The perception of the risks is dependent on many factors such as location or trust in the competent authorities but most notably on the personal experience of previous disaster events (Scolobig et al. 2012). In this study we use social memory of past disasters as a proxy to explore the effect of risk awareness on the efficiency of a relevant element of flood risk management, i.e. Flood Early Warning Systems (FEWS).

METHODS

The concept of risk awareness is difficult to quantify. Here we follow the approach by Di Baldassarre et al. (2013), who considered risk awareness to build up through psychological shocks immediately after a flood event and to exponentially decrease thereafter as the memory of the event fades. Changes in risk awareness are expected to affect the response capabilities after the issuing of a warning. Following this reasoning, residual losses

related to the application of mitigation actions can be thought to be dependent on the risk awareness level.

The warning system evaluation procedure is based on the widely used relative economic value (REV) methodology (Verkade & Werner 2011). The REV approach compares the losses avoided by the actual FEWS with the losses that would be avoided by a perfect warning system. For this case study the methodology is adapted to compare the damage avoided by a warning system when risk awareness is taken into account respect to the case when this variable is not taken into account.

The analysis is performed for a synthetic data set characterized by predefined flood frequency distribution and forecasting performance based on Di Baldassarre et al. (2013) and Nester et al. (2012) respectively. Using a synthetic dataset constructed from actual climatic variability is a useful approach for testing hypotheses for long data series that would otherwise be not available, but at the expense of making the results less comparable to actual events. This approach is suitable at this stage of exploratory tests. The obtained results, however, need to be considered with caution until they have been confirmed for real situations.

RESULTS

Risk awareness is shown to significantly vary through time following the occurrence of flooding events (Fig.1 c). Sudden increases in risk perception are observed after disaster events while for periods with no disasters risk awareness rapidly diminishes. This parameter also has a strong impact on the efficiency of FEWS in reducing disaster induced damages. Even if the performance of the forecasting procedure is the same in both cases (Fig.1 b), losses are observed to be larger when the risk awareness term is included. Low risk awareness levels discourage mobilization and, make response actions less effective, which results in higher

residual damages. These results highlight the importance of social risk awareness for early warning purposes and the need to take actions directed at preserving the memory of past disaster events. Higher risk awareness values lead to a more efficient response to warnings and thus to an increased warning efficiency, which contributes to mitigate disaster-related damages.

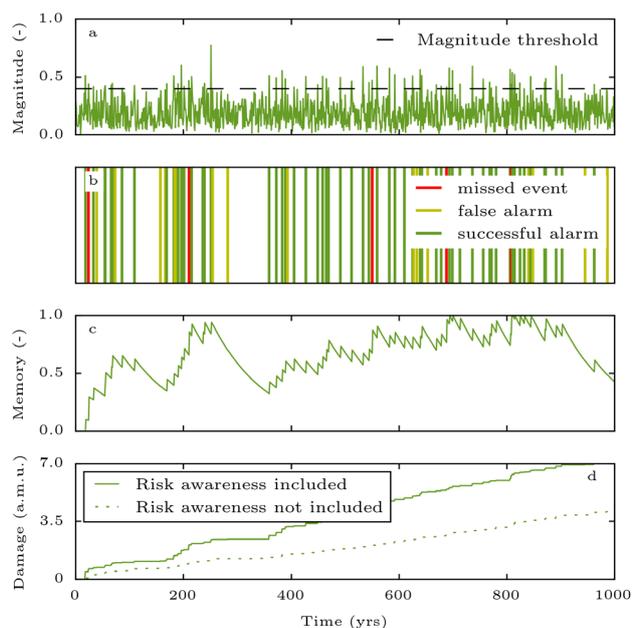


Figure 1. Effect of the risk awareness parameter on the efficiency of a predefined FEWS over time. (a) Time series of events with their corresponding magnitude. Events over the established warning threshold should be warned for. (b) Forecast performance as indicated by the different possible outcomes of the contingency table. Correctly rejected events are not represented for simplicity purposes. (c) Evolution of the normalized risk awareness term through psychological shocks due to disaster events and successive decay. (d) Cumulative disaster induced losses expressed in Arbitrary Monetary Units (a.m.u.) for the cases including and excluding the risk awareness term from the evaluation of the FEWS.

CONCLUSION

Behavioural aspects play a significant role in flood risk management and in FEWS. Memory strongly influences social behaviour in disaster situations as it directly affects risk awareness and the subsequent response to early warnings. The impact of risk awareness on the efficiency of FEWS has been tested in the present study for a synthetic case scenario. Reduced risk awareness is found to be

KEYWORDS

risk awareness; warning system; flood damage; memory; Mitigation

correlated with lower warning and response efficiency leading to higher disaster induced losses. Efforts on preserving social memory of past natural disasters are therefore deemed important for the success of disaster damage mitigation measures such as early warning systems.

REFERENCES

- Di Baldassarre G. et al. (2013). Socio-hydrology: Conceptualising human-flood interactions. *Hydrology and Earth System Sciences*, 17, pp.3295-3303.
- Basher R. (2006). Global early warning systems for natural hazards: systematic and people-centred. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences*, 364(1845), pp.2167-82.
- Buchecker M. et al. (2013). The role of risk perception in making flood risk management more effective. *Natural Hazards and Earth System Science*, 13, pp.3013-3030.
- Nester T. et al. (2012). Flood forecast errors and ensemble spread-A case study. *Water Resources Research*, 48(10), pp.1-19.
- Parker D.J., Priest S.J., Tapsell S.M. (2009). Understanding and enhancing the public's behavioural response to flood warning information. *Meteorological Applications*, 114(January), pp.103-114.
- Scolobig A., De Marchi B., Borga M. (2012). The missing link between flood risk awareness and preparedness: Findings from case studies in an Alpine Region. *Natural Hazards*, 63(2), pp.499-520.
- Verkade J.S., Werner M.G.F. (2011). Estimating the benefits of single value and probability forecasting for flood warning. *Hydrology and Earth System Sciences*, 15, pp.3751-3765.

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