



Influence of behavioral biases on the assessment of multi-hazard risks and the implementation of multi-hazard risks mitigation measures: case study of multi-hazard cyclone shelters in Tamil Nadu, India

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In December 2004, a multiple hazards event devastated the Tamil Nadu province of India. The Sumatra –Andaman earthquake with a magnitude of $M_w=9.1-9.3$ caused the Indian Ocean tsunami with wave heights up to 30 m, and flooding that reached up to two kilometers inland in some locations. More than 7,790 persons were killed in the province of Tamil Nadu, with 206 in its capital Chennai. The time lag between the earthquake and the tsunami's arrival in India was over an hour, therefore, if a suitable early warning system existed, a proper means of communicating the warning and shelters existing for people would exist, than while this would not have prevented the destruction of infrastructure, several thousands of human lives would have been saved.

India has over forty years of experience in the construction of cyclone shelters. With additional efforts and investment, these shelters could be adapted to other types of hazards such as tsunamis and flooding, as well as the construction of new multi-hazard cyclone shelters (MPCS). It would therefore be possible to mitigate one hazard such as cyclones by the construction of a network of shelters while at the same time adapting these shelters to also deal with, for example, tsunamis, with some additional investment. In this historical case, the failure to consider multiple hazards caused significant human losses. The current paper investigates the patterns of the national decision-making process with regards to multiple hazards mitigation measures and how the presence of behavioral and cognitive biases influenced the perceptions of the probabilities of multiple hazards and the choices made for their mitigation by the national decision-makers.

Our methodology was based on the analysis of existing reports from national and international organizations as well as available scientific literature on behavioral economics and natural hazards. The results identified several biases in the national decision-making process when the construction of cyclone shelters was being undertaken. The availability heuristics caused a perception of low probability of tsunami following an earthquake, as the last large similar event happened over a hundred years ago. Another led to a situation when decisions were taken on the basis of experience and not statistical evidence, namely, experience showed that the so-called "Ring of Fire" generates underground earthquakes and tsunamis in the Pacific Ocean. This knowledge made decision-makers to neglect the numerical estimations about probability of underground earthquake in the Indian Ocean even though seismologists were warning about probability of a large underground earthquake in the Indian Ocean. The bounded rationality bias led to misperception of signals from the early warning center in the Pacific Ocean. The resulting limited concern resulted in risk mitigation measures that considered cyclone risks, but much less about tsunami. Under loss aversion considerations, the decision-makers perceived the losses connected with the necessary additional investment as being greater than benefits from mitigating a less probable hazard.