Rational Allocation of Resources for Mitigating Future Natural Disasters: an Earthquake Scenario

D. Berleant[1] **and G. Yuce**[2]

[1]Department of Information Science
[2]Department of Applied Science
University of Arkansas at Little Rock
Little Rock, AR 72204
emails: berleant@gmail.com; igyuce@ualr.edu

Abstract

It is a fact that a major earthquake will strike Memphis; the city should prepare. Yet an engineering economics analysis of how much to spend preparing is impeded by numerous and severe uncertainties. It has been said, "Prediction is difficult, especially about the future." But prediction must be done, and its uncertainties accounted for, if resources for preparation are to be rationally allocated.

The uncertainty involved in predictions about future events typically includes an epistemic component (i.e. ignorance), and traditional approaches do poorly in taking this into account. Using unsupported distributions so that an answer can be derived is an approach that, while popular, nevertheless gives unsupportable answers. Worst case analyses can fail to account for information that, while valuable in principle, cannot be used by the particular analysis technique being applied. Instead, techniques are needed that flexibly permit modeling and computing with combinations of stochastic, epistemic, and perhaps other kinds of uncertainty. Such techniques should also provide meta-conclusions as appropriate, about how to rationally seek more information so that needed conclusions can be drawn.

To meet these needs in the context of an earthquake scenario, we propose to model the expected financial loss due to earthquakes in a given area (e.g. Memphis) per year, and the sensitivity of this loss to preparatory expenditures oriented toward loss reduction. The focus will be state-of-the-art representation of uncertainties in a simple model. An important justification for this approach is that complex models have more uncertainties than simpler ones, simply because they have more parameters that are unlikely to be known with certainty. Uncertainty computations will represent uncertainty using probability boxes and the DEnv algorithm [1] for computing with them. A requirement for usefulness of the model is that it be possible to conclude that the sensitivity is less than (or greater than) one, because such a conclusion states that it is worth (or not worth) preparatory expenditures. The proposed approach will use Information-Gap Theory [2] to determine recommendations for seeking appropriate uncertainty-reducing information in cases where the uncertainty in the sensitivity is such that the sensitivity is not shown to be below (or above) one. This is important because otherwise it would not be possible to conclude whether preparatory expenditures are worthwhile or not. This work is in progress.

References

[1] Berleant, D. and J. Zhang, "Representation and problem solving with Distribution Envelope Determination (DEnv)," *Reliability Engineering and System Safety*, vol. 85, no. 1-3, pp. 153-168, 2004.

[2] Ben-Haim, Y., *Info-Gap Decision Theory: Decisions Under Severe Uncertainty*, 2nd edition. Academic Press, 2006. *Information-Gap Decision Theory*, 1st edition. Academic Press, 2001.