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Earthquake induced disasters synergy: a game theory approach

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The probabilistic nature of seismic hazard process has always placed decision makers in an awkward position, as far as stages I (mitigation) and II (preparedness) of disaster management are concerned. For these stages, the deterministic approach of seismic scenarios or a successful earthquake prediction would be preferable. However, deterministic seismic scenarios are not necessarily realistic, as cost benefit analysis requires. In addition, earthquake prediction has not yet provided specific answers to the question “when, where and how big will be the earthquake”. These questions pose a serious ethical problem to geoscientists, on how to use their scientific results in risk-communication (L’Aquila case). In practice, geoscientists and decision makers follow different approaches, deontology (right) and consequentialism (good for society), characterized by their dissenting views of the relation between right and good, according to the ethical theory.

In natural disaster management research, game theory models consider government agencies and private companies interacting as players in a disaster relief game. Usually these models are two-player models, but when there is a multi-agency collaboration, the models become multi-player games. A two-player game between an attacker and a defender can be defined as: (1) sequential where attacker moves first, (2) sequential where defender moves first and (3) simultaneous (Seaberg et al, 2017).

A destructive earthquake is considered as the ‘attacker who moves first’ and the decision makers as the ‘defenders’. When the earthquake process is initiated, various automated mechanisms are activated as defense actions (e.g. real time Peak Ground Acceleration - Velocity distributions and Early Warning Systems, EWS). For responders, stage III (response) phase has begun.

In the timeline of an earthquake-related disaster, the earthquake occurrence initiates stage III. Post-earthquake induced phenomena, such as large aftershocks, landslides and tsunami, which, in some cases, have proved more or less as disastrous as the mainshock itself, are still at stage II. In such cases, the attacker (earthquake) is not a stable ‘dummy’ player, attacking once and for good, but it has a more dynamic behavior, as it is able to activate the attack of its ‘fellow players’, thus causing worse repercussions.

In this study, we seek to apply the model after the earthquake occurrence, also by incorporating earthquake induced phenomena. More specifically, we attempt to re-design the game tree suggested by Wu (2015) for “policy selection related to earthquake prediction” in the sense of policy selection related to the synergy of the above-mentioned earthquake related natural hazards. We apply this game tree in the cases of Atalanti (Greece) 1894, Brežice (Slovenia) 1917, Cephalonia (Greece) 1953, Tohoku (Japan) 2011 and Lefkada (Greece) 2014 earthquakes and compare the effects of the mainshocks and their induced phenomena.

References

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