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# **Decision Aid Models for Disaster Management and Emergencies**

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*Da Ruan unexpectedly passed away on July 31, 2011, once this book was already launched. Born in Shanghai, September 10, 1960, Da Ruan got his Ph.D. at the University of Ghent, Belgium, 1990, Etienne Kerre being his Ph.D. advisor. He had been working at SCK • CEN, Belgium, since 1991, launching in 1994 the FLINS conference series, and the ISKE conference series in 2006. Da Ruan was the founder of the International Journal of Computational Intelligence Systems, currently the official journal of European Society for Fuzzy Logic and Technologies (EUSFLAT), and he has also served as Editor of this Atlantis Press' Computational Intelligence Systems series. Da Ruan was the editor of 36 books and the author of more than 270 papers in journals and conferences. Leader of many fuzzy logic projects within nuclear science, decision systems and risk analysis, Da Ruan was a hard worker, helpful and inspirational colleague, good friend and an honest and warm-hearted person. His friends and his beloved family will miss him forever.*

# Preface

## Decision aid models for disaster management and emergencies

Begoña Vitoriano<sup>1,\*</sup>, Javier Montero<sup>1,2,\*</sup>, and Da Ruan<sup>3,†</sup>

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A disaster is understood as the disruption of the normal functioning of a system or community, which causes a strong impact on people, structures and environment, and goes beyond local capacity of response. In the global world of the 21<sup>st</sup> century, a disaster that occurs anywhere of the planet affects to the whole human Society. All regions on The Earth are interconnected and any serious problem in any region will not only have direct and terrible consequences on that region, but it will also hit the social and/or economic structure of other countries. The dimension and circumstances of each disaster will determine the relief level needed (regional, national or international), but anyway they require a joint provision strategy of many regions and the concurrence of International Organizations, Governmental and Non-Governmental.

Disaster management implies a number of actions to be developed before disaster happens, during the disaster and after disaster takes place. Authorities at all levels as well many businesses create some sort of preventive measures and plans to reduce the disaster effects and return to normal function as quickly as possible, and from the experience learn how to improve prevention and reaction.

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<sup>†</sup>Prof. Da Ruan unexpectedly passed away on 31 of July 2011 after launching this book.

Response to natural disasters (e.g., floods, earthquakes) or technological (e.g., nuclear, chemical) is an extreme complex process that involves severe time pressure, various kind of uncertainties, and many stakeholders. Disaster management often requires several autonomous agencies to collaboratively mitigate, prepare, respond, and recover from heterogeneous and dynamic sets of hazards to Society. Almost all disasters involve high degrees of novelty to deal with most unexpected various uncertainties and dynamic time pressures. Existing studies and approaches within disaster management have mainly been focused on some specific type of disasters with certain agency oriented. There is a lack of a general framework to deal with similarities and synergies among different disasters by taking their specific features into account.

This book provides with various decision analysis theories and support tools in complex systems in general and in disaster management in particular. The book is also generated during a long-term preparation of a European proposal among most leading experts in the areas related to the book title.

After a general call among specialists and a standard peer review process, we sincerely hope that this book becomes a reference in the field since it addresses not only a state-of-the-art first section and third section devoted to original application oriented advances, but also a second section that offers alternative approaches to deal with the different kinds of uncertainties that appear in disaster management and emergencies.

This book starts with an introduction to the important role of information on disaster management and emergencies by A. Pedraza. In this introduction, some main challenges in humanitarian logistics are described. Among other key issues, the author points out the collaboration needed between different parties collaborating in disaster response and the need of incorporating dynamic forecast of disasters in decision aid models. Three specific examples involving the use of information in humanitarian operations are discussed more in detail, involving techniques from operations research, operations management, and management science.

The first section of this book, devoted to an overview of the state-of-the-art, contains four papers. In the first paper, M.T. Ortuño *et al.* state main definitions concerning disasters, emergencies and humanitarian logistics, and focus the review on decision aid models and systems developed until now in the area. In the second paper, F. Liberatore *et al.* offer a general overview of the different problems that become a source for uncertainty in humanitarian logistics in the context of disaster management, as well as the main techniques used until now (risk mappings, probability, stochastic programming, optimization, simulation

and fuzzy models), offering a brief description of main references. In the third paper, B. Öztaysi *et al.* focus on Fuzzy Inference Systems and their applications for disaster management, showing an example in order to allow a quick and flexible solution for spontaneous volunteer management. In the fourth paper of this section, D. Tang *et al.* present a literature review in security based operations, focussing in current and expected future research in container line supply chains divided into three categories (general regulations, specific security issues and risk analysis tools).

The second section presents four different alternatives to deal with uncertainties in disaster management and emergencies. In the first paper of this section, L. Zou *et al.* present two approaches for fuzzy risk analysis in order to handle both comparable and incomparable linguistic information by means of information aggregation techniques and taking into account 10 linguistic evaluation values. In a second paper, J. Liu *et al.* offer a belief rule-based generic risk assessment framework for modelling, analyzing and synthesizing risk-related information with various uncertainties, where risk factors are described using linguistic variables in order to capture uncertain casual relationship between the risk factors and the special risk estimate. In a third paper, M.A. Abchir *et al.* stresses again that report and descriptions of the disaster that will support emergency management in their first stages are usually expressed linguistically by witnesses, so the authors offer a procedure to help to express diagnosis of the catastrophic event based upon such a natural language. In the fourth paper, in order to deal the lack of information of decision makers, H. Bustince *et al.* present a new method to amalgamate the opinions of several experts based upon interval-valued information.

Finally, last section is devoted to applications, containing this time five papers. Since a precise numerical evaluation of a potential disaster is unrealistic, the first paper by J.T. Rodríguez *et al.* reformulates this problem as a severity classification procedure, offering a bipolar classification methodology based upon the notions of semantic antagonism and dissimilarity structure. In a second paper, the problem of transshipment multi-commodity supply chain flow for humanitarian relief operations is addressed by A. Clark *et al.*, offering a model to assist policy makers and planners to design an effective supply chain so that goods and service can reach those in need as quickly as possible, a model validated with real life data from the South Asian Earthquake of October 2005. In the third paper of this section, M. Leon *et al.* take advantage of Fuzzy Cognitive Maps to represent the behaviour and operations of transport managing, showing how travellers base their decisions on their perception of available information. A hierarchical assessment framework



for evaluating safety against fire and explosion hazards in container line supply chains is presented by Y.W. Chen *et al.*, following a Evidential Reasoning approach which is tested data collected from the Port of Liverpool. Finally, M. Naderpour *et al.* develop a Human Situation Awareness Support System which has the ability to support the operators' understanding and assessing the disaster, and by applying fuzzy risk assessment concepts allow a better inference of the real situation and project its status in the near future.

We have to finish this preface acknowledging the key role that our missed friend Da Ruan played in the conception of this book. In fact, the idea of this book emerged while he was spending two months as Distinguished Visitor at Complutense of Madrid, invited by B. Vitoriano within a program that pretends to bring to this University extremely qualified researchers with leadership to launch new projects. Da Ruan perfectly fitted this description, and devoted a long time discussing with us ideas about common fields of interest. This book is one of the projects we discussed, launched while he was still in Madrid, focussed on researchers and practitioners demanding new approaches, particularly those coming from Non Governmental Organizations. Along his short life, Da showed a tremendous capability to launch new projects, putting together people from many different fields, either at the academy or at the industry. Da was a taught worker, a kind person and a friend we could always count on. We miss him.

We deeply appreciate the support of members of Spanish Red Cross, Action Against Hunger and other Non Governmental Organizations that have been collaborating with us. We hope that this book will be helpful for their objectives and bring more researchers into this complex and multi facet field by means of a book that intends to become a reference text for research and practice within disaster management and emergencies.

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