

Preface: *Dynamics of Disasters: Algorithmic Approaches and Applications*

Springer International Publishing Switzerland, 2018, pp. v-viii.

Ilias S. Kotsireas, Anna Nagurney¹, and Panos M. Pardalos

This volume is a collection of carefully reviewed papers presented at the 3rd International Conference on Dynamics of Disasters held in Kalamata, Greece, July 5-9, 2017, with additional invited papers. The conference was organized by Ilias S. Kotsireas, Anna Nagurney, and Panos M. Pardalos and convened disaster researchers to discuss their latest scientific work. This volume of 8 papers is organized alphabetically by the first initial of the last name of the first author of each paper with highlights of each paper given below.

The co-editors of this volume are very grateful to the authors of the papers that appear in this volume and also acknowledge the referees for their valuable reports on the papers.

Omkar Achrekar and Chrysafis Vogiatzis in the first paper in this volume, “Evacuation Trees with Contraflow and Divergence Considerations,” tackle the important problem of evacuation planning, in the face of an upcoming disaster, in which vehicles utilize the available transportation road network in order to reach safe locations in the form of shelters. They emphasize that, in order to successfully evacuate vehicles located in danger zones, the evacuation process needs to be fast, safe, and seamless. They propose an integer programming model that is based on the concept of an evacuation tree, in which they allow for two policies: contraflow, consisting of lane and street reversals to allow for a higher level of vehicular flow, and divergence, in which evacuees can diverge from the tree under certain conditions. According to the definition of an evacuation tree, vehicles are only allowed to follow one path to safety at each intersection. The authors illustrate the applicability of their framework on two networks, based on the Sioux Falls network and on the Chicago network, accompanied by extensive computational testing and sensitivity analysis, considering both different cost functions as well as budgets. The solution of their model reveals that it is possible to achieve faster network clearance when utilizing more resources. In addition, after a certain budget limit on the number of contraflows or divergences, the evacuation does not become any faster.

Fuad Aleskerov and Sergey Demin in their paper, “Modelling Possible Oil Spills in the Barents Sea,” discuss the rapid increase of the oil and gas industry growth in the Barents Sea during the last few years. They point out that while the Arctic zone is considered to

¹Anna Nagurney thanks the Radcliffe Institute for Advanced Study at Harvard University for its support through the Summer Fellowship Program to complete the co-editing of this volume.

be a relatively clean area, there is a certain number of “hot spots” in the Arctic due to the activities of various companies. They study the problems connected with production of two types of fossil fuel and carried out a simulation model. This model shows the results of oil or gas flowing accident related to drilling complex, taking into account sea currents. By using this model, they can highlight areas in the Barents Sea with the highest potential of the disaster so that preventive measures could be taken. In addition, this model helps to organize elimination of fossil fuel flowing consequences.

Ioanna Falagara Sigala and Fuminori Toyasaki in their paper in this volume, “Prospects and Bottlenecks of Reciprocal Partnerships between the Private and Humanitarian Sectors in Cash Transfer Programming for Humanitarian Response,” discuss the state of the art in practice and in research regarding Cash Transfer Programming (CTP) as an alternative to commodity-based programming, that is, in-kind aid for disaster relief. CTP, in contrast to in-kind aid, transfers purchasing power directly to beneficiaries in the form of currency, which allows them to procure goods and/or services from local markets. In CTP, the private sector, and, especially financial service providers (FSPs), which are entities that provide financial services, including e-transfer services, are essential. FSPs can include e-voucher companies and financial institutions, such as banks and microfinance institutions. Falagara Sigala and Toyasaki, in their study, which is based on primary and secondary qualitative data, present the main characteristics and the mechanisms of CTP to explore how the private sector is involved, identify bottlenecks of reciprocal relationships between financial service providers and humanitarian organizations in CTP, and unveil challenges for the private and humanitarian sectors, which hinders its implementation. This is the first study to explore the partnership of the private sector and the humanitarian sector in CTP, and also describes promising avenues for future research, including new trends in financial donation flows.

Lina Mallozzi and Roberta Messalli in their paper, “Equilibrium Analysis for Common-Pool Resources,” present an aggregative normal form game to describe investment decision making for Common-Pool Resources (CPR). A CPR is a natural or human-made resource, from which a group of individuals can benefit, such as, for example, open-seas fisheries. A problem with which a CPR copes is overuse. Indeed, since a CPR is a subtractable resource, that is, its supply is limited, if the quantity that can be restored is overused then there will be a shortage of it, which can result in the destruction of the CPR. The authors consider two directions in order to solve such a problem: the non-cooperative one, characterized by a Nash equilibrium, and the cooperative one, in the form of a fully cooperative equilibrium. They provide existence results for both and, in the case of Environmental Economics, the authors compute and compare the equilibria and then introduce a threshold investment and study

the resulting game with aggregative uncertainty. Since an immense range of environmental problems, such as climate change, the loss of biodiversity, ozone depletion, the widespread dispersal of persistent pollutants, and many others, involves the commons, such as, for example, forests, energy, industries, water, and so on, this paper has numerous applications.

Anna Nagurney in her paper, “A Multitiered Supply Chain Network Equilibrium Model for Disaster Relief with Capacitated Freight Service Provision,” constructs a multitiered game theory model in which the cost-minimizing behavior of disaster relief organizations is captured and that of competing, capacitated freight service providers who are contracted to deliver relief item supplies to multiple points of demand. The governing equilibrium conditions are formulated as a variational inequality problem and existence results provided. The algorithmic approach fully exploits the network structure of the problem and is applied to a timely case study focusing on delivering personal protective equipment to medical professionals battling Ebola in western Africa. The case study reveals that humanitarian organizations benefit from a larger number of competitive freight service providers (although this affects freight service providers negatively in terms of profits). Also, the addition of humanitarian organizations competing for services from the freight service providers results in higher prices since the capacities may be achieved. The paper adds to the literature on game theory and disaster relief, which has only minimally been explored.

Anna Nagurney, Patrizia Daniele, Emilio Alvarez Flores, Valeria Caruso, in their paper, “A Variational Equilibrium Network Framework for Humanitarian Organizations in Disaster Relief: Effective Product Delivery Under Competition for Financial Funds,” present a novel Generalized Nash equilibrium network model, which integrates competition for financial funds among disaster relief organizations and their logistical response post disasters to provide needed supplies to victims. The humanitarian organizations are subject to common, that is, shared constraints, consisting of lower and upper bounds on the delivered supplies at points of demand with the former guaranteeing that the victims’ needs will be met and with the latter constraints reducing material convergence and congestion. The network model is formulated and solved as a variational inequality problem, using a recently introduced concept of a Variational Equilibrium. Lagrange analysis is then utilized to investigate qualitatively the humanitarian organizations’ marginal utilities if and when the equilibrium relief item flows are (or are not) at the imposed demand point bounds. The proposed algorithm yields closed form expressions, at each iteration, for the product flows and the Lagrange multipliers, and is applied to a case study, inspired by rare tornadoes that caused devastation in parts of Massachusetts in 2011. The solution to the Nash equilibrium counterparts of the examples making up the case study, in which the common demand bound constraints

are removed, are also presented, and demonstrate that victims may not receive the required amounts of supplies, without the imposition of the demand bounds. These results provide further support for the need for greater coordination in disaster relief, as made possible by the new model, and show that, by delivering the required amounts of supplies, the humanitarian organizations can also acquire more financial donations, creating a win-win situation.

Ladimer S. Nagurney in his paper, “Advances in Disaster Communications: Broadband Systems for First Responders,” begins by overviewing technological changes to public safety disaster communications over the past 90 years from the initial use of wired and simple two-way radios to the advanced broadband systems available to today’s first responders. He illustrates how the information and communications needs of first responders have evolved and how coordination and cooperation among various agencies is not the norm. He highlights the challenges and opportunities faced by first responders when not only traditional radio systems are available, but the responders have the ability to use a variety of smart devices connected together through a broadband infrastructure. In this paper, Nagurney also describes the First Responder Network, FirstNet, which is a robust broadband infrastructure in the United States specifically tailored to the needs of first responders. He delineates how a public-private partnership is used to implement FirstNet and reviews the extensions to current broadband technology that will enhance its usefulness to first responders. The author reviews complementary technologies and how they may be used in conjunction with FirstNet. Since first responder use of broadband is not just an American issue, he also discusses current and planned public safety broadband networks across the globe. Nagurney concludes his paper by listing open-ended questions that still need to be solved, including the premier one, is the political/business model sustainable?

Papadaki et al. in the final paper in this volume, “A Humanitarian Logistics Case Study for the Intermediary Phase Accommodation Center for Refugees and Other Humanitarian Disaster Victims,” are discussing the recent refugee crisis in Europe as an example of issues arising from the forced mass movement of populations. Some aspects of the theoretical background include historical data regarding the displacement of populations in the European region from the 19th century onwards together with the underlying political and economical causes, statistical data highlighting the characteristics and particularities of the current refugee wave and indicating the possible repercussions these could inflict and finally, the relevant international, European and national legislation and policies, as well as their potential shortcomings. They then proceed with the proposal of an accommodation center project constructed from modified shipping containers to function as one of the initial stages in adaptation before full social integration of the displaced populations. Some of the

key design features include compliance with all current guidelines and regulations regarding space allocations and function, compact overall size suitable even for small plots and incorporation of several environmental technologies. Regarding the primary function, the accommodation center aims to address significant human needs far beyond food and shelter, such as basic health care, education, administrative assistance and initiatives for social integration, with the overall goal to maximize the respect for human rights and values while minimizing the impact on society and on the environment. Furthermore, the versatility and specific characteristics of the project make it suitable for any type of humanitarian disaster, thus expanding the original scope significantly and creating a useful tool in all humanitarian relief operations.

Ilias S. Kotsireas

Director, CARGO Lab
Wilfrid Laurier University
Department of Physics and Computer Science
75 University Avenue West
Waterloo, ON, N2L 3C5, Canada
e-mail: ikotsire@wlu.ca

Anna Nagurney

John F. Smith Memorial Professor
Director, Virtual Center for Supernetworks
Department of Operations and Information Management
Isenberg School of Management
University of Massachusetts
Amherst, MA, 01003, USA
email: nagurney@isenberg.umass.edu

Panos M. Pardalos

Distinguished Professor
Paul and Heidi Brown Preeminent Professor
in Industrial and Systems Engineering
Director, CAO
Industrial and Systems Engineering
University of Florida
401 Weil Hall

P.O. Box 116595
Gainesville, FL 32611-6595, USA
e-mail: pardalos@ufl.edu