DISEA

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A Dynamic Integrated Model for Disaster Management and Socio-Economic Analysis

Workshop on

Modeling Urban Resilience in the Aftermath of the Haifa Fire

Thursday 2nd February 2017

Room 3610, Department of Geography, Hebrew University of Jerusalem,
Mt Scopus, Jerusalem

THE HEBREW UNIVERSITY OF JERUSALEM

TOHOKU UNIVERSITY

IRIDeS International Research Institute of Disaster Science 災害科学国際研究所

JST

משרד המדע, הטכנולוגיה והחלל
Ministry of Science, Technology & Space

Participation is free but requires prior registration via mail sarita@savion.huji.ac.il or telephone 02-5881292 until 25.1.17

Program

Session 1: 10:00-12:20

A Comprehensive Approach Towards Earthquake-Related Casualty Modeling,
Stav Shapira, Ben Gurion University of the Negev

Medium Term Dynamics of Urban Resilience: The Case of the Labor Market after an Earthquake,
Yair Grinberger and Daniel Felsenstein, Hebrew University of Jerusalem

Gauging Urban Resilience Using Social Media Analytics,
Dmitry Leykin, Mooli Lahad and Limor Aharonson-Daniel, Ben Gurion University of the Negev

Analysis of Building Damage Mapping Technique Using Seismic Fragility Functions: A Case Study of the 2016 Mw 7.0 Kumamoto Earthquake,
Luis Moya, IRIDeS, Tohoku University, Japan

Urban Resilience and the Identification of Disaster-Affected Populations: An Algorithm for the Spatial Allocation of Socio-Economic Data,
Daniel Felsenstein and Peleg Samuels, Hebrew University of Jerusalem

Earthquake casualty loss assessment in a major city of Israel: the case of Tiberias
Igal M. Shohet, Ben-Gurion University of the Negev

Lunch Break: 12:20-13:30

Session 2: 13:30-15:30

Lessons of Tsunami Evacuation Behavior and Simulation Models to Support Evacuation Planning,
Erick Mas, IRIDeS, Tohoku University, Japan

Evaluation of Tsunami Evacuation Time Using a Deterministic Model,
Emri Brickner, Michelle E. Portman, Amos Salamon and Pnina Plaut, Technion-Israel Institute of Technology and Geological Survey of Israel

Modeling Multiple Ignition Scenarios for Assessment of Firefighting Strategies,
Yonatan Shaham, Tel Aviv University

Transportation Planning for Emergency and Rehabilitation: Estimating the Role of the Transportation System in Population Resilience,
Guy Keren, Hebrew University of Jerusalem

Remote Sensing of Wildfires and the Importance of the Wildland-Urban Interface,
Noam Levin, Hebrew University of Jerusalem

Abstracts

A Comprehensive Approach Towards Earthquake-Related Casualty Modeling

Stav Shapira, Ben Gurion University of the Negev

The use of casualty modeling in the field of disaster management is well established. Currently, it is based exclusively on damage to the built environment; and fails to consider additional factors that may influence the number of casualties in a given event, such as behavioral features of the exposed population. The present study has integrated behavioral traits of residents in an urban setting, into a well-known casualty estimation model. The expected behavioral characteristics of residents during an earthquake, in city sectors with different socioeconomic rankings, were assessed using a designated survey and were applied into the model. A sensitivity analysis was performed, by conducting twelve earthquake simulations.

The simulation results demonstrated a clear link between expected behavior and casualty projections. Taking into account behavioral traits of residents changed the total number and composition of expected casualties. Households with low socioeconomic status were found to be more vulnerable in terms of risk of injury and death compared with those ranked higher. The results shed light on the relationship between specific behavioral strategies and casualty projections and suggest that loss-estimation models that do not take behavioral factors into account may overestimate projected casualty number. Raising public awareness regarding proper behavior during the event can help mitigate risks and losses and ultimately save lives.

Medium Term Dynamics of Urban Resilience: The Case of the Labor Market after an Earthquake

Yair Grinberger and Daniel Felsenstein, Hebrew University of Jerusalem

Large scale shocks destroy the urban fabric. As such the impacts invariably studied are those relating to urban stocks such as housing, critical infrastructure etc. However urban flows are also disrupted but they have received much less attention. A key flow relates to the operation of the labor market. This paper examines just how different flow disruptions are from stock disruptions. Do they have a shorter or longer time horizon? Do they bounce back faster or slower? Using a newly developed urban simulation model we examine the labor market dislocations associated with a large scale shock and compare these to stock-related dislocations. Key labor market outcomes examined are unemployment, job-switching and accumulated earnings (representing time in employment).

Gauging Urban Resilience Using Social Media Analytics

Dmitry Leykin, Mooli Lahad and Limor Aharonson-Daniel,
Ben Gurion University of the Negev

Community resilience was previously defined as community's ability to withstand crises or disruptions and was assessed, during the past few years using novel self report assessment tool, which is called The Conjoint Community Resiliency Assessment Measure (CCRAM). According to the CCRAM model, community resilience is manifested in five key: Leadership, Collective Efficacy, Preparedness, Place Attachment and Social Trust.

Social media enables many individuals from different communities and cities gather to one virtual space, where enormous amount of information flows in rapid rate between individuals. In this virtual space, physical communities (e.g. Towns, villages) and organizations run patterns of daily life, that include two-way processes of information flow between different people holding different roles in the community (e.g. leaders, citizens, random visitors).

With the rise of social media, the abonnement of user-generated content, public APIs for social media services and the availability of efficient data extraction and analytical tools – researchers and practitioners can explore in detail citizen' attitudes towards various issues in their external environment. This presentation describes existing tools for social media data extraction & analytics and demonstrates how community resilience can be assessed from social media content.

Analysis of Building Damage Mapping Technique Using Seismic Fragility Functions: A Case Study of the 2016 Mw 7.0 Kumamoto Earthquake

Luis Moya, IRIDeS, Tohoku University, Japan

This paper shows the flowchart to estimate building damage during earthquake scenarios that is intended for the use of the project DIM2SEA (A Dynamic Integrated Model for Disaster Management and Socio-Economic Analysis). The procedure estimates different levels of damage for different structural systems in Japan. We present the tools used for that purpose such as QuiQuake, which provides a quick estimation of strong ground motion distribution maps, and empirical fragility curves obtained from the 1995 Hyogoken-Nanbu (Kobe) earthquake. In this procedure, first buildings with the same characteristics (i.e., same material, construction period, and same ground intensity) are grouped. Then, within each group buildings are randomly classified as either non-damage, moderate damage, or heavy damage. The amounts of buildings for each level of damage have to be proportional to the likelihood of state of damage obtained from the fragility curves. The procedure is applied to the Mashiki town during the 2016 Mw 7.0 Kumamoto earthquake, which caused extensive damage to buildings, bridges and transportation structures. Besides, our results were contrasted with collapsed buildings detected from Lidar data.

Urban Resilience and the Identification of Disaster-Affected Populations: An Algorithm for the Spatial Allocation of Socio-Economic Data

Daniel Felsenstein and Peleg Samuels, Hebrew University of Jerusalem

A key factor in understanding urban resilience is detailed baseline knowledge of the populations affected in urban disasters and their spatial distribution. Invariably, this information is not available or exists at a level of spatial resolution too coarse to be useful. This paper deals with developing a dedicated allocation algorithm for data disaggregation and the generation of synthetic spatial microdata. We present an approach that generates national scale data that can then be reconfigured at any spatial scale. This involves combining census tract (CT) level data with GIS buildings layers in order to generate synthetic spatial microdata. The method uses 'Synthetic Reconstruction' for artificially generating data and Iterative Proportional Fitting (IPF) for the sequential adjustment of synthetic data so that it corresponds to known marginal distribution of the population. Spatial allocation is based on a (reverse) Alonso-type mechanism that recreates individual preferences on the basis empirical prices. Processing procedures are fully automated and the database and spatial allocation can be updated as new data become available. The operation of this method is illustrated with respect to the spatial distribution of emergency rescue and relief services in the case of an hypothetical flooding scenario for Nahariya. Validation of the spatial allocation is provided.

Earthquake casualty loss assessment in a major city of Israel: the case of Tiberias

Igal M. Shohet, Ben-Gurion University of the Negev

Mitigating the consequences of potential earthquakes requires an estimation of the casualties that may incur, and accordingly development of an appropriate risk management and response model. Based on an extensive literature review of the consequences of earthquakes, the following parameters were identified as a significant factor in estimating human casualties: (1) the earthquake related hazards in the designated area, namely the seismic shaking, amplification of the ground acceleration, surface rupture, soil liquefaction, landslides, and tsunamis; (2) the vulnerability of the structures to the seismic hazards. This is assessed by an empirical or analytical approach that combines simulation of seismic events, reaction of the ground, the capacity of the building stock; and (3) vulnerability of the population due to its socio-economic conditions and demography in the designated area.

Lessons of Tsunami Evacuation Behavior and Simulation Models to Support Evacuation Planning

Erick Mas, IRIDeS, Tohoku University, Japan

Extreme tsunami events in the 21st century have demonstrated that amongst several mitigation measures at tsunami prone areas, evacuation is the most effective mean to save human lives. The 2004 Indian Ocean, 2010 Chile and 2011 Japan tsunamis killed hundreds to thousands of residents and tourists in the area. The main reasons of such death tolls are discussed here from the evacuation behavior point of view. In addition, tsunami numerical simulation and evacuation simulation are discussed in this presentation. Tsunami numerical simulation aids to discover the tsunami threat level by the estimation of tsunami height, tsunami arrival time and tsunami inundation extent. These basic information is used when planning evacuation support systems. Tsunami hydrodynamic features are calculated using non-linear shallow water equations. On the other hand, evacuation depends on information dissemination and human behavior in response to a potential tsunami threat. Unfortunately, tsunami evacuation drills are not enough to evaluate the status quo of mitigation measures or the effect of future mitigation measures. In response to this, tsunami evacuation simulation aid on the analysis of more realistic scenarios of evacuation and evaluation of mitigation measures. To support evacuation planning, these two technologies are integrated to evaluate the tsunami threat to human. Besides the human casualty estimation, other possible applications of a tsunami evacuation simulation will be presented here.

Evaluation of Tsunami Evacuation Time Using a Deterministic Model

Emri Brickner, Michelle E. Portman, Amos Salamon, Pnina Plaut,Technion-Israel Institute of Technology and Geological Survey of Israel

Experts recently concluded that Israel is at significant risk of tsunami impact; a preparation and response policy has been established by the national emergency management authority. Nonetheless there are still gaps in the national tsunami preparedness policy. There is currently no method by which to evaluate the evacuation time, there are no tools to assess the factors that affect evacuation and information is lacking on how statutory urban planning influences mass evacuation. Considering the above policy gaps, the research objective of this study is to evaluate the urban and planning factors that influence tsunami evacuation time in order to provide a decision-making support tool using timeline analyses. To achieve this objective, we developed an analytical deterministic evacuation model based on a road network analysis taking the 'Least Cost Distance' approach. We modeled a set of sensitivity scenarios using a GIS platform, changing one factor at a time. The variables are classified according to three criteria: population, city structure, and evacuation planning policy. The use of this method answers the question of whether there is enough time to evacuate, 'edge to edge' under given optimal and suboptimal conditions and considers how aspects of statutory planning that could improve evacuation.

Modeling Multiple Ignition Scenarios for Assessment of Firefighting Strategies

Yonatan Shaham, Tel Aviv University

Each fire is a main risk to life and property. In routine circumstances, the capacity of urban firefighter forces is sufficient to react to the fires and the great majority of fires are successfully extinguished during the first 5 – 15 minutes after ignition and their damage is limited. Multiple Simultaneous Ignition (MSI) scenarios are relatively rare while pose much greater threat to cities. MSI become possible in case of severe wild fires, fires following earthquake, war and rocket launching or industrial catastrophes, and the forces necessary for fighting them are far beyond regular firefighter forces. In the circumstances of MSI response to some of the fires will be delayed and some may be left without response at all. Therefore, firefighters have to prioritize under extreme scarcity and uncertainty.

MSI calls for new firefighting strategies that account for the lack of the firefighting forces and the essential uncertainty of fire locations and stage. These strategies cannot be evaluated by simple extrapolation, since essential dependence of the scenario dynamics on the instantaneous decision of the firefighters. I suggest evaluating such strategies with the high-resolution model fire spread for Mediterranean and Middle-Eastern cities. The study of this model clearly demonstrates that fire spread in Mediterranean and Middle-Eastern cities is sensitive to the spatial patterns of constructions and vegetation. My next step will be evaluation of various strategies of MIS firefighting with the spatially-explicit Agent-Based model of firefighters' response that is built on the top of the fire spread model. Such a model is now in development.

Transportation Planning for Emergency and Rehabilitation: Estimating the Role of the Transportation System in Population Resilience

Guy Keren, Hebrew University of Jerusalem

Escape is sometimes the most effective solution for saving lives in a disaster. In this study, we estimate the role of the transportation system in the overall resilience of populations to disaster. The study evaluates variables that affect population possibilities for escape and for the delivery of aid. Based on this analysis, we assess the contribution of the transportation system to population resilience. We use GIS Agent Based Modeling that simulates the behavior of individuals/households in an emergency. For each agent, we calculate a scenario-based escape route and by aggregating agent behavior we get an overall evacuation simulation. Based on the simulation, we evaluate accessibility of each building in the city in any scenario of roadblocks (and for each type of mobility). We also predict congestion on roads, assess the service area of aid and give a weighted survival score to the overall transportation system ability to cope with the disaster and its contribution to population resilience. For example, for each building we estimate estimated arrival time of MDA ambulance emergency services from the nearest ambulance station and time of arrival at the nearest hospital. The method is demonstrated for the city of Haifa.

Remote Sensing of Wildfires and the Importance of the Wildland-Urban Interface

Noam Levin, Hebrew University of Jerusalem

Wildfires are expected to increase in Mediterranean landscapes as a result of climate change and changes in land-use practices. The spatial and temporal dynamics of wildfires are a function of two independent processes: fire ignition and fire propagation. Whereas fire propagation is highly dependent on the meteorological conditions and on fuel availability, fire ignition in Mediterranean regions is mostly related to human activities (negligence or arson). The importance of the wildland-urban interface in understanding fire patterns is not only related to the greater number of fires starting there, but also to the greater risks to human lives and to properties in built-up areas, and thus more emphasis is focused on efforts to control and extinguish fires in populated areas. Remote sensing offers us with means to monitor and quantify past changes and patterns of wildfires, providing several key parameters (such as the time, size and spatial configuration of fires, as well as burn severity) to understand the risks which fires pose to populated areas. Spatial analysis of remotely sensed derived estimates of fires combined with spatial datasets of vegetation, built-up areas and demographic properties, enables us to understand some of the causes of fires close to populated areas. This presentation covers these aspects based on experience in the study of wildfires.