THIRD WESTERN - ICLR MULTI-HAZARD RISK AND RESILIENCE WORKSHOP

November 3 & 4, 2022

Book of Abstracts

NORTHERN TORNADOES PROJECT

Institute for Catastrophic Loss Reduction

Building resilient communities

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Contents

2022 Western-ICLR Multi-hazard Risk and Resilience Workshop

Climate change increases the frequency and intensity of extreme weather events and amplifies the impacts of other natural hazards. It negatively affects Canada and other parts of the world, causing fatalities, economic losses, and damage to infrastructure systems. Extreme weather events, failure of climate-change mitigation and adaptation, and natural disasters are the top risks. The insurance industry warns that climate change could cut the world economy up to $23 trillion by 2050. Although hazard-specific challenges have been well studied and now broadly understood, there are critical gaps in understanding risks that are driven by cascading and compounding hazards, and in creating innovative solutions to mitigate the impact of extreme disaster events particularly in the changing climatic environment. Future innovators and leaders within the industry and government need technical knowledge that crosscuts multiple traditional disciplines and a deep understanding of the complexity and interdependency of economic and social factors. In responding to these needs, Western's Multi-Hazard Risk and Resilience group and the Institute of Catastrophic Loss Reduction hosted the 2019 and 2021 Multi-Hazard Risk and Resilience workshops[1].

The ***2022 Western-ICLR Multi-hazard Risk and Resilience Workshop*** brings together researchers and professionals from different disciplines who are studying disasters and engage key stakeholders from government/municipality and industry. It will provide a forum to discuss these risks and how they relate to these end users.

The workshop was hosted on November 3rd and 4th, 2022 at the Physics and Astronomy Building in the Western University's Main Campus in London, Ontario. The main mode of the workshop was in-person but allowed hybrid participations for those who were interested in the workshop and were unable to travel.

[1] https://www.uwo.ca/multihazard_risk_resilience/events/index.html


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Organization

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Greg Kopp
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Session Organization

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Douglas Woolford - Johanna de Haan Ward
Katsu Goda - Cindy Mora-Stock
Ayan Sadhu
Reza Najafi - Mohammad Fereshtehpour
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The workshop organizers wish to express their sincere thanks to the Departments and Organizations that have made this collaboration possible:

- Department of Earth Sciences
- Department of Statistical and Actuarial Sciences
- Department of Civil and Environmental Engineering
- Department of Geography
- Institute for Catastrophic Loss Reduction (ICLR)
- Northern Tornadoes Project (NTP)

Full Program

Abstracts provided when available or contact authors for further information
Slides available for provided talks on the Workshop's website

Thursday November 3rd, 2022

Session #1 Wind and hail hazards and risks

(Lead by Northern Tornado Project / Northern Hail Project)
Conveners: Greg Kopp

Severe convection in Europe: climate modelling and forecasting
Dr. Pieter Groenemeijer (*pieter.groenemeijer[at]essl.org*)
European Severe Storms Laboratory

An Overview of Severe Weather Research at the National Severe Storms Laboratory
Dr. Alan Gerard (*Alan.E.Gerard[at]noaa.gov*)
Warning Research and Development Division at NOAA National Severe Storms Laboratory

The Northern Hail Project: A renaissance in hail research in Canada
Dr. Julian Brimelow (*jbrimelo[at]uwo.ca*)
Northern Hail Project

Tornadoes and Derechoes – Event Data and Climatologies in Canada
Dr. Dave Sills (*david.sills[at]uwo.ca*)
Northern Hail Project

Session #2 Wildland fire hazards and risks

(Lead by Doug Woolford & Johanna de Haan Ward)
Conveners: Doug Woolford

Measuring Dependence Between Wildland Fire Ignitions and Sizes – Lightning and Person
Dr. Devan Becker (*dbecker[at]wlu.ca*)
Wilfrid Laurier University

Wildland Fire in Ontario
Aaron Stacey (*aaron.stacey[at]ontario.ca*)
Aviation, Forest Fires, and Emergency Services, Ontario MNRF

Assumptions and thresholds in wildfire modelling: uncertainty and its impact
Dr. Mike Wotton (*mike.wotton[at]utoronto.ca*)
Canadian Forest Service & U. Toronto

Session #3 Natural hazards and disaster risk reduction for British Columbia

(Lead by Katsu Goda & Cindy Mora-Stock)
Conveners: Katsu Goda, Kevin Potoczny

Hazards in British Columbia: Observations and Lessons Learned
Kevin Potoczny, Yao Li, Parva Shoaeifar, Mahmoud Bagheri
(*Kpotoczn[at]uwo.ca*)
Multi-hazard Risk and Resilience Collaborative Program, Western University

Landslide Hazards in British Columbia, overview and challenges
Dr. Sergio Sepúlveda (*ssepulve[at]sfu.ca*)
Simon Fraser University

The application of geological, geotechnical, and geophysical data to seismic microzonation in Metro Vancouver
Sujan Adhikari (*sadhika6[at]uwo.ca*)
Western University

Tsunamis and landslides – Comparative Geohazard Risk in British Columbia
Dr. Steve Evans (*sgevans[at]uwaterloo.ca*)
University of Waterloo

Session #4 Young Researchers: Geological and Geosocietal Hazards - Mixed

Conveners: Cindy Mora-Stock

Enhancement of Urban Floodwater Mapping from Aerial Imagery with Dense Shadows via Semi-Supervised Learning

Yongjun He (*yhe563[at]uwo.ca*)
Department of Geography and Environment, Western University

Timely and accurate floodwater mapping in urban areas from aerial imagery is critical to support emergency response. Although considerable improvements in flood mapping have been made in many deep learning-based studies, most state-of-the-art works ignore the massive shadows over urban areas and require a large amount of labelled data for model building. In this study, we present a novel consistency learning-based semi-supervised learning framework to map flooding in urban areas with dense shadows. Experimental results on the 2013 Calgary flood demonstrates the effectiveness of our approach on extracting visible floodwater with only a few labelled samples.

Building-scale flood risk analysis by first floor height estimation using a deep-learning-based approach

Nafiseh Ghasemian Sorboni (*nghasem2[at]uwo.ca*)
Department of Geography and Environment, Western University

Flood vulnerability analysis is critical to reducing flood direct and indirect impacts. First Floor Height (FFH) is an essential parameter for flood vulnerability analysis and insurance premiums. Traditional methods for FFH estimation were based on ground surveys and site inspection, but these approaches were quite time-consuming and labor-intensive. In this work, an approach based on measurements on Google Street View (GSV) images and Deep Learning (DL) was proposed for Greater Toronto Area (GTA) to estimate FFH without any site inspection. Also, a flood risk map for the lower don region was generated based on FFH values and basement information extracted from GSV images.

Compound flooding risk analysis over the Canadian coastal environments

Farshad Jalili Pirani (*fjalilip[at]uwo.ca*)
Department of Civil and Environmental Engineering, Western University

Characterizing compound inland flooding in a changing climate

Mohammad Fereshtehpour (*mferesht[at]uwo.ca*)
Department of Civil and Environmental Engineering, Western University

Comprehensive and Robust Projection of Compound Dry-Wet Whiplash in North America

Dr. Wooyoung Na (*wna4[at]uwo.ca*)
Department of Civil and Environmental Engineering, Western University

Spatiotemporal Changes of Lagged Compound Dry and Wet Spells in the Northwest North America Under Climate Change

Reza Rezvani (*rrezvani[at]uwo.ca*)
Department of Civil and Environmental Engineering, Western University

A vision towards a performance-based design approach for tall structures merging wind and seismic effects

Amaya Ballate Delgado (aballate[at]uwo.ca)
Universidad Tecnológica de La Habana "José Antonio Echeverría" (CUJAE, Cuba) & Western University

The wind design of buildings is typically based on strength provisions under ultimate loads. This is unlike the ductility-based approach used in seismic design, which allows inelastic actions to take place in the structures under extreme seismic events. This presentation is a part of an extensive research program conducted to merge the design concepts used under seismic and wind effects in order to produce a sustainable design approach and improve the resilience of buildings. The current research is done in collaboration between researchers at Western University led by Dr. El Damatty and researchers at the Technical University of Havana, Cuba, led by Dr. Martin. This presentation will introduce the framework of the new coupled wind/seismic concept, will present its application on a real sixty-five story building previously tested for wind effects at the Boundary Layer Wind Tunnel Laboratory, and will discuss future work.

Waveform Similarity of Microseismicity at the Tony Creek Hydraulic Fracturing Site

Jin Yang (*jyang927[at]uwo.ca*)
Western University

Deep learning framework bridges lab and field scale microseismic focal mechanism

Arnold Yuxuan Xie (*yxie469[at]uwo.ca*)
Western University

Geo-energy extraction and geologic storge have great potential to mitigate climate change, however the subsurface fluid injection and extraction involved can trigger seismicity causing damage to surrounding facilities and residence, as reported at geothermal plants in Pohang, Soultz, Basel, etc. The seismicity is attributed to the subsurface pore pressure and poroelastic perturbations generated by volume changes. These volume changes can be determined from microseismic waveforms detected across a geophone array by considering the moment tensor. However, full moment tensor inversion can be poorly constrained for field events due to signal resolution and completeness limitations. Microseismic and acoustic emission events have identical mechanisms, so in this work we consider a large dataset of full-moment tensor inverted acoustic emission waveforms. The waveforms were acquired from laboratory hydraulic fracturing and beam bending experiments on granite and shale samples, which are used to fine tune the feature interpretation modules of a single-channel deep convolution neural network pretrained for seismic signal first motion polarity classification. This allows us to reformulate the task from first motion polarity to volume change polarity using only a single waveform. The model shows accurate prediction on both laboratory and field test dataset.


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Friday November 4th, 2022

Session #1 Infrastructure management and risk mitigation

(Lead by Western's Smart Cities group & ICLR)
Conveners: Ayan Sadhu

KEYNOTE: Risk, Resilience and Sustainability of Infrastructure under Multihazards
Dr. Dan Frangopol (*dan.frangopol[at]lehigh.edu)*
Lehigh University, USA

Decisions regarding design, assessment and maintenance of infrastructure should be supported by an integrated risk-, resilience- and sustainability-based life-cycle multi-objective optimization framework by considering, among other factors, the likelihood of successful performance and the total expected cost accrued over their entire life. The primary objective of this keynote lecture is to present a life-cycle multi-objective optimization framework for risk-, resilience- and sustainability-informed decision making for infrastructure under multihazards including corrosion, earthquake and climate change. Several important performance indicators such as risk, resilience and sustainability necessary to be implemented in the design, assessment and maintenance of infrastructure under single and multiple hazards are introduced. Bridges and bridge transportation networks are used to illustrate the application of the proposed approach.

Monitoring and Assessment of Infrastructure Using Sensor Measurements
Dr. Babak Moaveni (*babak.moaveni[at]tufts.edu*)
Tufts University

This presentation provides application of different monitoring approaches for performance and damage assessment of different structural systems using in-situ or remote measurements. The first part of my presentation is on performance assessment of RC buildings through a physics-based Bayesian inference approach using vibration measurements. In the second part, I present application of similar methods for assessment of an offshore wind turbine. In the third and last part, I show application of remote sensing and satellite imagery for global damage assessment of buildings.

Crowdsensing-based Monitoring of Built and Natural Environments (CoMBiNE)
Dr. Mustafa Gül (*mustafa.gul[at]ualberta.ca*)
University of Alberta

One of the grand undertakings of our modern age is to build smart, sustainable, and resilient cities that can be managed and operated efficiently while providing residents with a high level of safety and comfort. The path to

realizing smart cities is inherently complex and multi-dimensional, involving various technological and social aspects, and it requires fundamental shifts in management of our infrastructure and energy systems and close interaction among different disciplines. In this context, this presentation will discuss some of Dr. Gül's recent research efforts in developing smart, sustainable, and resilient cities and infrastructure systems. Dr. Gül will present a Crowdsensing-based Monitoring of Built and Natural Environments (CoMBiNE) framework for studying populations of infrastructure systems that capitalizes on the big data collected using the existing sensors and cameras within connected vehicles (and other systems).The talk will specifically focus on using smartphones in vehicles for drive-by monitoring of populations of bridges, using rear-mounted cameras for pavement assessments, as well as using in-vehicle cameras for assessment of wildland-urban-interface fire risk. Finally, future research directions toward achieving smart, sustainable, and resilient cities and communities will be outlined.

Session #2 Climate Change and Society

(Lead by Western Centre for Climate Change, Sustainable Livelihoods and Health)
Conveners: Isaac Luginaah, Mirindi Eric Dusenge

Disaster Risk Governance as a Guide to Canadian Policy Responses to a Global Health Emergency
Dr. Rosalind Warner (*rowarner[at]okanagan.bc.ca*)
Okanagan College, BC

How well do nature-based climate solutions address gender equity
Dr. Hanson Nyantakyi-Frimpong (*Hanson.Nyantakyi-Frimpong[at]du.edu*)
University of Denver, Colorado

Building Climate Resilient Communities – Social-Health-Policy Dimensions.
Dr. Gordon McBean (gmcbean[at]uwo.ca)
Western University

Risks and opportunities to harness digitalisation for a sustainable planet
Dr. Éliane Ubalijoro (eliane.ubalijoro[at]futureearth.org)
McGill University


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Implications of climate change for sustainable urban environments
Dr. Yuyu Zhou (*yuyuzhou[at]iastate.edu*)
Iowa State University, USA

Session #3 Hydroclimatic extremes in a changing climate (part I)

Conveners: Reza Najafi, Mohammad Fereshtehpour

Insights into the Impact of Melting Arctic Ocean Ice Cover
Dr. Ed McBean (*emcbean[at]uoguelph.ca*)
U. Guelph

A Different Look to Hazard, Vulnerability and Risk in Extreme Events: The value of Crowd Sourcing, Data Assimilation and Machine Learning
Dr. Hamid Moradkhani (*hmoradkhani[at]ua.edu*)
U. Alabama

Future climatic data for infrastructure design
Dr. Hamidreza Shirkhani (*hamidreza.shirkhani[at]nrc-cnrc.gc.ca*)
National Research Council Canada (NRC)

Climatic data are of essential importance in designing buildings, bridges, water/wastewater systems, transportation, and other types of infrastructure. Typically, climatic loads and design values in building and infrastructure codes, standards and guidelines are obtained through analyses of historical climate data. However, under the changing climate, the historical-based climatic design values turn out to be less valid, which increases the infrastructure vulnerability and risk of failure. One of the major issues in implementing future climatic data in infrastructure design is the high degree of uncertainty stemmed from various sources such as future emissions and climate models uncertainties. In addition, the future climate process will become non-stationary that makes the problem even more complex, particularly for infrastructure with a longer design life. Understanding the principles of climate change and climate models that are pertinent to the design of civil engineering infrastructure can provide insights into the implementation of the future climatic data in buildings and infrastructure design codes and standards.

Changes in extreme precipitation: past and future
Dr. Xuebin Zhang (*xuebin.zhang[at]ec.gc.ca*)
Environment and Climate Change Canada (ECCC)

Session #4 Hydroclimatic extremes in a changing climate (part II)

Conveners: Conveners: Reza Najafi, Mohammad Fereshtehpour

Using Network Risk and Spatial Analysis to Predict Indirect Flood Damage: A Don River Example
Nick Martyn (*nick.martyn[at]risklogik.com*)
RiskLogik & U. Toronto

Interpreting Change in Peak Flow Design Values using Temperature Scaling
Markus Schnorbus (*mschnorb[at]uvic.ca*)
Pacific Climate Impacts Consortium (PCIC)

Snow drought and its implications on streamflow predictability in a warming climate
Dr. Raj Shrestha (*rajesh.shrestha[at]ec.gc.ca*)
Environment and Climate Change Canada (ECCC)

A warming climate is leading to periodic occurrences of exceptionally low snowpack condition or 'snow drought' in cold-climate regions, affecting mean and extreme streamflow, and causing economic and ecological impacts. The first part of this presentation will focus on a categorical framework to characterize snow drought for a range of conditions in the historical and future climates, and application for river basins in northwestern North America under 1.0 °C to 4.0 °C global warming thresholds above the pre-industrial period. Future projections of highly heterogeneous patterns of snow drought across the river basins, and frequent and severe snow drought in the southwestern basins, will be discussed. The second part of the presentation will summarize our recent research on advancing the understanding of future streamflow predictability, as it becomes more dependent on less reliable meteorological forecasts, and less dependent on more reliable snowpack initial condition. An ensemble streamflow prediction system that combines GCM and hydrologic model projections and isolates the effect of snowpack will be described. Results showing contrasting patterns of future changes in mean and extreme streamflow predictability that arise from the differences in river basin characteristics and interactions of streamflow with snowpack, precipitation and temperature will be discussed.


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A new concept of max-stable vector to analyze and predict the probability of unprecedented climate extremes

Dr. Mohamed Ben Alaya (*mohamedalibenalaya[at]uvic.ca*)
Pacific Climate Impacts Consortium (PCIC)

Accurate estimation of the occurrence of extreme precipitation events exceeding the maximum observed values is necessary for many technical mitigation and adaptation procedures. A frequently used approach to solve this type of problem involves the statistical theory of extreme values (EVT). As a solution, classical EVT uses the max-stability assumption, which only holds under certain regularity conditions. Extremes in nature, however, are likely to be non-regular and dependent. Here, we introduce a new empirical concept of a local max-stable vector to analyze and characterize non-regular dependent extremes. We show how the concept can be used to design an extreme value analysis procedure that is specific to precipitation. We illustrate the approach at several locations in Canada by conceiving a procedure guided by observations but also leverages additional information about variation deeper in the upper tail than can be obtained from observations that derive from a large ensemble of CanRCM4 simulations.

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