Chain Reaction: The Role of Transportation and Humanitarian Supply Chains in Mass Evacuation Planning

Mass Evacuation Speaker Series

June 2024

Purpose of this note:
On May 21st, 2024, MacEachen Institute for Public Policy and Governance at Dalhousie, in partnership with **CIFAL** and **Y-EMERGE** at York University and the **Institute of Intergovernmental Relations** at Queen's University, hosted a panel to discuss transportation and humanitarian supply chains in mass evacuation planning.

The panelists included **Dr. Ahsan Habib**, Director of Dalhousie Transportation Collaboratory (DalTRAC); **Dr. Ali Ülkü**, Director of Centre for Research in Sustainable Supply Chain Analytics at Dalhousie University; and **Erica Fleck**, Director of Emergency Management with the Halifax Regional Municipality.

About the Mass Evacuation Speaker Series

The Mass Evacuation Speaker Series is a joint initiative from CIFAL York and Y-EMERGE at York University; the MacEachen Institute for Public Policy and Governance at Dalhousie University; and the Institute of Intergovernmental Relations at Queen's University.

Author

Eva Eusanio
Research Assistant
MacEachen Institute for Public Policy and Governance | Dalhousie University
Email: **ev438314@dal.ca**

Contact

For more information on this research, contact **mipp@dal.ca**

Key Takeaways:

- It is crucial to create regional transportation plans for mass evacuations that identify vulnerable points. These regional plans should be practiced ahead of time, particularly in areas identified as particularly challenging.
- Mass evacuation planning should be considered through the lens of maintaining sustainable humanitarian supply chain systems.
- In cities with growing density, transportation and communication of emergency orders continue to be vulnerable points during a mass evacuation.
- It is vital to have a "whole of community" approach when developing an evacuation plan that involves practicing evacuations to build resilience.

Event Overview

This panel was the first event in a speaker series that engages academics and practitioners who work in emergency management and mass evacuation planning. The speakers primarily discussed the role of the humanitarian supply chain and transportation mapping in mass evacuation events, drawing predominantly from examples and research on the Halifax peninsula. After a short presentation from each panelist, there was a discussion period.

Event Partners

Panelists' Presentations

Dr. Ahsan Habib – Director of DaLTRAC, Professor at Dalhousie University School of Planning

"Mass Evacuation Modelling: A Multidisciplinary Analysis of Coastal Halifax"

Since extreme weather events are becoming more common, there needs to be a way to practice mass evacuations of urban areas. Dr. Habib's team developed a Mass Evacuation Decision Support tool (MEDS) to measure the flow of traffic on the Halifax peninsula. The peninsula is vulnerable to severe flooding, yet like many urban areas, it is inexperienced in mass evacuation planning. Dr. Habib's team used a traffic simulator to test a flood scenario. They considered strategic traffic flow areas including exits to highways, bridges and roundabouts. They ran the simulation model with multiple flood scenarios and discovered that in a 2.9-metre water-elevation flood it would take 22 hours to evacuate the entire peninsula, and a 7.9-metre flood would take 23 hours. With this new tool, they considered how to identify vulnerabilities (social, geophysical and mobility-related) in transportation. Using their vulnerability criteria, they tested different areas of Halifax and created staged evacuations. Figure 1 shows that with staged evacuations, some areas could be evacuated more quickly. The work is ongoing, and it shows how important it is to practice evacuation plans and identify vulnerable areas and populations when developing these plans.

Planning District	#TAZs	Total Evacuation Demand	Evacuation Start Time	Total Evacuation Time (Before Staging)	Total Evacuation Time (After Staging)	%Reduction in Evacuation Time
Downtown	7	31,000	10:00:00	21 hr. 45 mins	21 hr. 10 mins	0.07
West End	12	5628	14:30:00	6 hr. 45 mins	2 hr.	70.3
North End	21	22,500	16:00:00	18 hr. 10 mins	13 hr. 45 mins	24.3
South End	16	6332	16:00:00	7 hr.	4 hr.	42.8

Figure 1 – Shows the reduction in evacuation time after creating a staged evacuation plan. From Dr. Habib's presentation.

Dr. M. Ali Ülkü – Director of the Centre for Research in Supply Chain Analytics, Professor at Dalhousie University Faculty of Management

"The Role of Humanitarian Supply Chain in Mass Evacuation Planning: An Overview

There has been a sevenfold rise in climate-related events from 2000 to 2022, which increases the number of extreme-weather events and natural disasters. These disturbances have adverse effects on both commercial and healthcare supply chain performance. Dr. Ülkü's team defines sustainable humanitarian supply chains and shows how they are essential in a climate-changed world. These supply chains are vital to mass evacuation planning because they deliver vital aid to those in need during emergencies; however, the performance of these supply chains can be vulnerable to climate-related interruptions. Dr. Ülkü's recent work focuses on how

Climate-Related Disturbances	Examples	Supply Chain Impacts
Extreme Weather Events	Hurricanes, storms, floods, droughts, heatwaves	Disruption of transportation, damaged infrastructure, supply delays, increased logistics costs
Sea-Level Rise	Coastal inundation, erosion, saltwater intrusion	Damage to port facilities, coastal transportation disruptions, supply chain rerouting
Temperature Changes	Increased average temperatures, heatwaves	Impacts on perishable goods, increased energy costs for temperature control
Precipitation Changes	Changes in rainfall patterns, increased or decreased precipitation	Water scarcity, impacts on agriculture and raw material availability
Changes in Natural Disasters	Increased frequency and intensity of wildfires	Disruption of transportation routes, damage to facilities, supply chain interruptions
Glacier Retreat	Reduced freshwater availability, altered ecosystems	Impacts on water-intensive industries, changes in water-dependent SCs
Ocean Acidification	Harm to marine ecosystems, coral reef bleaching	Disruption of seafood SCs, impacts on aquaculture
Biodiversity Loss	Species extinction, disruption of ecosystems	Disruption of agricultural SCs, impacts on biodiversity-dependent industries
Changes in Agricultural Patterns	Altered growing seasons, crop yield fluctuations	Impacts on agricultural SCs, food production challenges
Disease Outbreaks	Expanded range of disease vectors, increased transmission	Disruption of labor availability, impacts on healthcare SCs

Figure 2 – Climate-related disturbances and corresponding supply chain impacts, from Dr. Ülkü's presentation.

artificial intelligence can be used to manage a sustainable humanitarian supply chain and how to measure donor behaviour in humanitarian crises. Developing sustainable humanitarian supply chains should involve the individuals and groups that are directly coordinating this planning, like civic groups, humanitarian organizations, first-aid responders and others. This will make mass evacuation planning resilient, comprehensive and sustainable.

Erica Fleck – Director of Emergency Management, Halifax Regional Municipality (HRM)
Halifax is one of the fastest-growing cities in Canada, and this poses a problem when it comes to mass evacuation planning. Increasing urban density, a coastline, a military base and a robust tourism season, all with limited egress, are present in Halifax. With a huge rise in weather-related emergencies like fires, floods and hurricanes, there have been unprecedented evacuations in the past few years. In the summer of 2023, there were 17,000 residents evacuated in a residential area due to a fire, which bought attention to the topic of evacuation strategy and the limited space in the HRM. One significant issue in mass evacuations concerns the willingness of citizens to listen to emergency orders and use public transit to evacuate. It is understood that citizens will panic and evacuate in their primary vehicle and get stuck in traffic. Based on Dr. Habib's research, there should be fewer vehicles on the road to reduce congestion and collisions during an evacuation. This points to the importance of mass transportation. In our growing urban area, public transportation has become more robust, and Halifax has sufficient capacity to do a large-scale evacuation. This would be the most effective use of resources. There needs to continue to be a "whole of community" approach when improving these plans. People from both urban and rural areas should be educated on how to safely evacuate with public transit. Involving academics, practitioners and community members will make evacuation planning more effective and resilient.

Discussion Highlights

- The barriers to the "whole of community" approach are education, communication and the inevitable panic that comes with emergencies. There should be a focus on practicing evacuation plans so people can feel comfortable and hopefully avoid road collisions or further risk. Cities are a weak point for communication and education on emergencies because people do not know their neighbours, so there is a tendency for a "every person for themselves" mindset that can cause panic.
- Halifax Regional Municipality is conducting a Hazard Risk and Vulnerabilities Assessment—the first of its kind in Canada. It will look at all vulnerabilities in the municipality (6,000 sq km). The assessment will take national data and layer it onto local vulnerabilities to improve understanding of mass evacuations.
- Often, citizens will panic, take their primary vehicle and avoid taking public transit in a mass evacuation. This varies region to region, but it is important to create mass evacuation drills and education in rural communities to familiarize people of all backgrounds and abilities with using public transit.
- Since there are so many variables in mass evacuation planning, every stakeholder needs to be involved in creating evacuation plans in every region.

Further Reading

Alam, M. J., & Habib, M. A. (2021). Mass Evacuation Microsimulation Modeling Considering Traffic Disruptions. Natural Hazards, 108, 323-346. https://shorturl.at/wJJry

Alam, M. J. (2021). Development of a Mass Evacuation Decision Support Tool, PhD Dissertation, Dalhousie University. https://shorturl.at/KyYKN

Halifax Regional Municipality. "Hazard, Risk and Vulnerabilities Assessment". From HRM Website https://shorturl.at/O7xOb

Halifax Regional Municipality. "Voluntary Vulnerable Persons Registry". From HRM Website https://rb.gy/2b1c3t

Yun, N. Y., & Ülkü, M.A. (2023) Sustainable Supply Chain Risk Management in a Climate-Changed World: Review of Extant Literature, Trend Analysis, and Guiding Framework for Future Research. Sustainability, 15, 13199. https://doi.org/10.3390/su151713199

Ülkü, M. A., Bell, K. M., & Wilson, S. G. (2015). Modeling the impact of donor behavior on humanitarian aid operations. Annals of Operations Research, 230(1), 153-168. https://doi.org/10.1007/s10479-014-1623-5

Ülkü, M. A., Bookbinder, J. H., & Yun, N. Y. (2024). Leveraging Industry 4.0 Technologies for Sustainable Humanitarian Supply Chains: Evidence from the Extant Literature. Sustainability, 16(3), 1321. https://doi.org/10.3390/su16031321

MacEachen INDEPENDENT. INFORMED.

About the MacEachen Institute

The MacEachen Institute for Public Policy and Governance at Dalhousie University is a nationally focused, non-partisan, interdisciplinary institute designed to support the development of progressive public policy and to encourage greater citizen engagement. www.dal.ca/MIPP

About the Institute of Intergovernmental Relations

The Institute of Intergovernmental Relations (IIRG) at Queen's University is Canada's premier university-based centre for research on all aspects of federalism and intergovernmental relations, both in Canada and in countries around the world. www.queensu.ca/iigr

---

About CIFAL York

CIFAL York is part of UNITAR's global network of training centers for knowledge-sharing, training, and capacity-building for leaders, local authorities, and civil society. www.yorku.ca/cifal

---

About Y-EMERGE

Y-EMERGE YORK EMERGENCY MITIGATION, ENGAGEMENT, RESPONSE AND GOVERNANCE INSTITUTE

York Emergency Mitigation, Engagement, Response, and Governance Institute (Y-EMERGE) is a pan-university Research Institute at York University, focusing on science, technology and human and social aspects of disaster and emergency management. www.yorku.ca/research/yemerge