A Resilience-based, mobility-driven Decision Support System for Multi-Modal Transport Networks

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With the increased frequency and magnitude of extreme environmental events in Scotland in the last decade, one of the proposed priority areas for the Second Scottish Climate Change Adaptation Programme is to provide climate change resilient transport systems (Figure 1). A key factor in achieving this goal is to develop a management system that operates across transport modes, appreciates the inherent interdependencies between different modes, implements mobility patterns, identifies primary vulnerable zones and prioritises investments and supports resilience capacity building accordingly.

Currently, transport asset management systems work in isolation, addressing single-mode transportation networks without considering connections and mobility patterns/shifts between different modes. This approach neglects cascading failures due to inherent connections between modes of transport and hence underestimates the amplified negative consequences due to these failures, under extreme weather events. A more scientific approach to quantify these interdependencies could offer opportunities in shared intervention measures where mode shifts could be implemented in emergency systems.

The project aims to produce a decision support framework, that assesses failure propagation due to inherent interdependencies in multi-modal transport networks. This project builds on lessons learnt from a feasibility study entitled: Resilience and Vulnerability-based Decision Support System (RV-DSS) considering Infrastructure interdependencies. The project will start by developing a geospatial database of a multi-modal transport system, integrating geometric, topological, semantic and operational data from different modes of transport. You will then build a novel inference system that can identify and classify the spatial and temporal correlations in different modes of transport. The output from this model will be then used as an input in a multi-agent network system to be tested on a wide range of climate change-induced hazardous scenarios. Given your interest and progress, you will have the flexibility in adjusting and focusing on different aspects of producing the multi-modal decision support framework.

Figure 1 - Extreme Weather-Induced failures in different modes of transport

Training opportunities:

You will gain experience in infrastructure interdependencies, network modelling of transport systems, building and training deep learning algorithms and developing a resilience-based asset management system. You will be co-supervised by a Principal Consultant at Jacobs' Asset Management & Business Intelligence, benefiting from extensive experience in transport asset management practice. During this project, you will have the opportunity to visit and interact directly with members of this team at their HQ in London. Jacobs is the largest and most diverse provider of technical, professional and construction services including all aspects of architecture, engineering and construction, operations and maintenance, as well as scientific and speciality consulting.

In addition, you will be able to attend advanced postgraduate modules at University of Surrey related to the PhD topic and keynote lectures carried out by infrastructure professionals. You will have access to the SCENARIO and Surrey Doctoral College training opportunities plus receive support through regular contact with academics, industrial advisors, your PhD peers and other SCENARIO students.

Student profile:

This project is suitable for students with an engineering-related, mathematical, environmental or transport degree (either undergraduate or postgraduate) or professional experience in engineering. Motivation and enthusiasm for studying a multi-disciplinary problem that combines environmental sciences with engineering analysis will be desired.

Funding particulars:

Eligible students will receive the usual NERC award including stipend and university fees.