A SYSTEM-PERSPECTIVE FOR CLIMATE-RESILIENT BRIDGES AND TRANSPORT NETWORKS

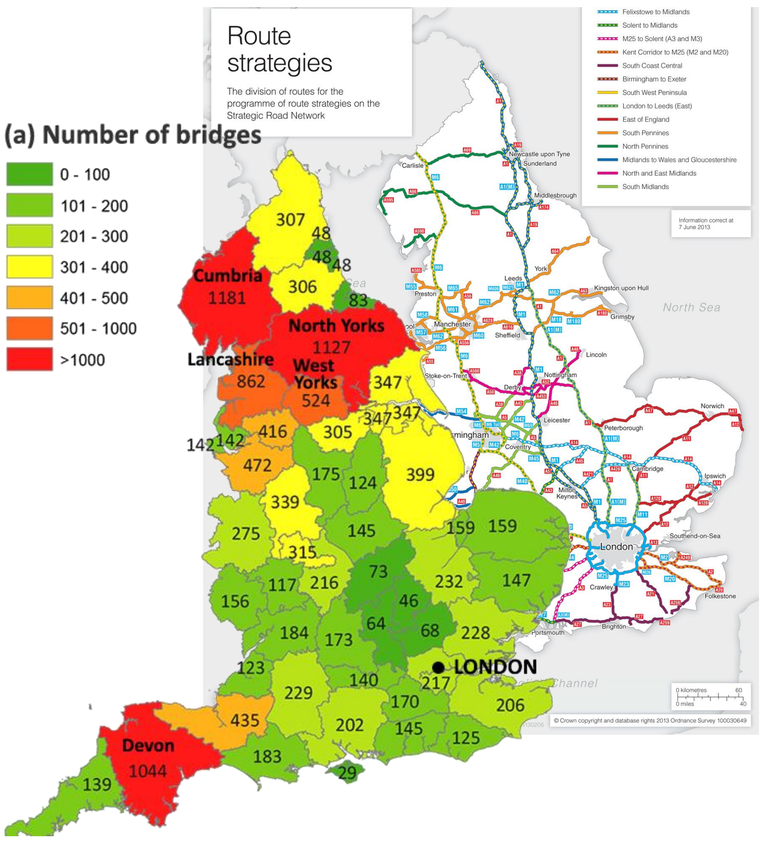
University of BRISTOL

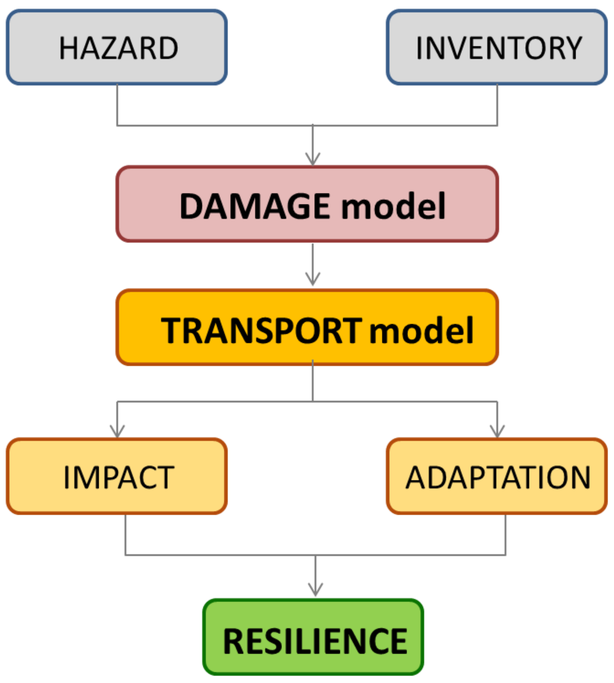
Dr Maria Pregnolato

maria.pregnolato@bristol.ac.uk

Maria Pregnolato

MariaPregnolat1





Flooding impacts **bridges** as single **structural** elements and as **network** elements of the wider transportation system. A **systematic** integration of the bridge performance into network analysis supports more rational **bridge management** strategies.

Take a picture to KNOW MORE

INTRODUCTION

Flooding is the most impactful natural hazard in the UK, and the increased frequency of flooding is the most significant risk to UK infrastructure due to climate change. According to CCRA 2, the number of infrastructural assets exposed to flooding could double under changes in climate by the 2080s. Moreover, the impacts of climate change could be further amplified by interconnectivities and interdependencies between infrastructure sectors. Bridges are particularly a critical element in the network, for their intrinsic exposure to floods and crucial role in overcoming obstacles; also, they could carry utilities (e.g. water pipes). Whilst many studies have investigated monitoring and structural analysis of bridges susceptible to failure, our understanding is still limited regarding the implications of their failure on the wider transport network. This understanding is fundamental to enable risk-based decision-making and prioritisation of limited funds for maintenance and enhancing national resilience.

METHODS

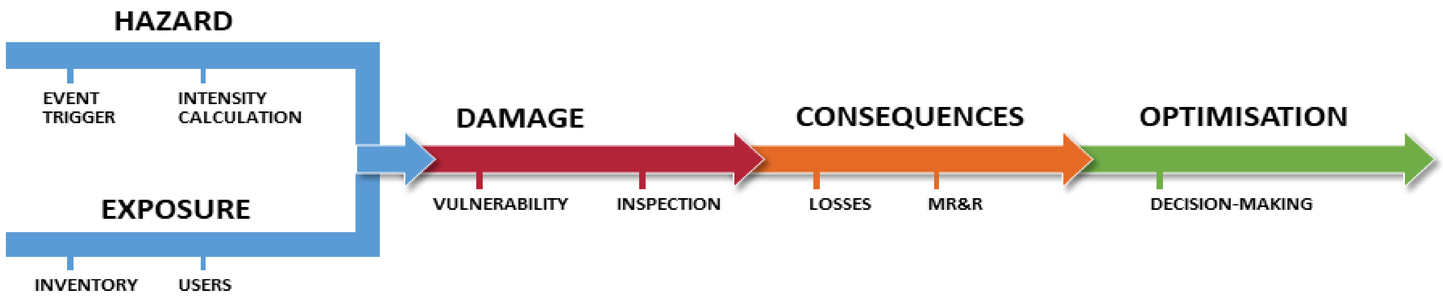
This paper develops a holistic methodology for assessing bridge vulnerabilities and failures due to flood-induced phenomena. It demonstrates how flood modelling, computational fluid dynamics, reliability analysis and network analysis can be jointed to understand the impact of flooding to bridges and the surrounding network. The methodology is applied to the flood-prone city of Carlisle (UK), for a flood scenario of reference (2015 winter flood). The research draws on the principles of a risk-based approach to assess the hydrodynamic effects of floods on bridges and moves these forward by advancing a network-level analysis. This research will help to fill the gap between current guidance for design and assessment of bridges relevance within the overall transport system, highly inadequate for evaluating these risks, in light of the increasing external pressures.

RESULTS

The current unavailability of high-quality data and the consequent lack of understanding of bridge performance jeopardise bridge safety, and hinder the ability to prioritise resources. The UK, as for many other countries, should not take bridge safety for granted and should take precautionary preventative action for defining a new programme for bridges at risk of floods.

FUTURE WORK

A case study in Carlisle is on-going for carrying out: (i) risk analysis for a set of flooding scenarios, by means of damage curves; (ii) economic appraisal of bridge disruption (e.g. identifying the bridges whose failure would lead to the largest economic costs); (iii) emergency planning (e.g. identifying which bridges have to remain operational during evacuation/rescue operations).



KEY REFERENCES

Highways England (2012). The Assessment of Scour and Other Hydraulic Actions at Highway Structures (BD 97/12), Design Manuals for Roads and Bridges (DMRB). London: Highways England.

Kirby et al. (2015). Manual on scour at bridges and Web hydraulic structures (C742), CIRIA, London (UK)

Mondoro and Frangopol (2018). Risk-based cost-benefit analysis for the retrofit of bridges exposed to extreme hydrologic events considering multiple failure modes. Eng Struct, 159: 310-319

Pregnolato (2019). Bridge safety is not for granted – A novel approach to bridge management. Eng. Structures, 196: 109193

maria.pregnolato@bristol.ac.uk

This work was supported by the Engineering and Physical Sciences Research Council (ESPRC) LWEC (Living With Environmental Change)fellowship (EP/R00742X/1 and 2); the author gratefully acknowledges the Department for Transport and Highways England for the support.