Modelling approaches to inform and improve community resilience and evacuation response

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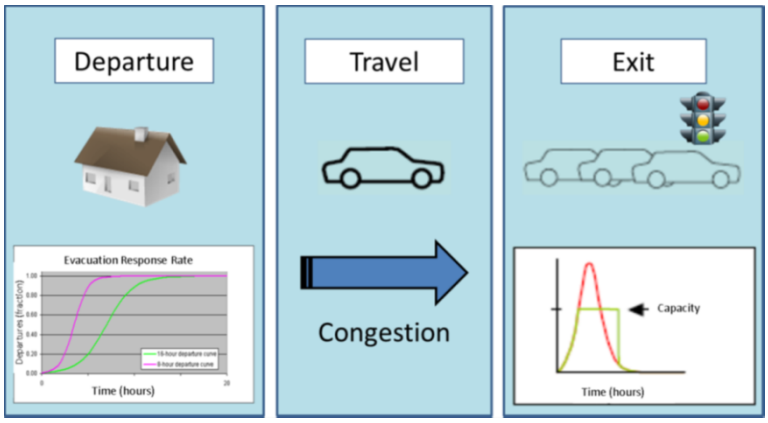
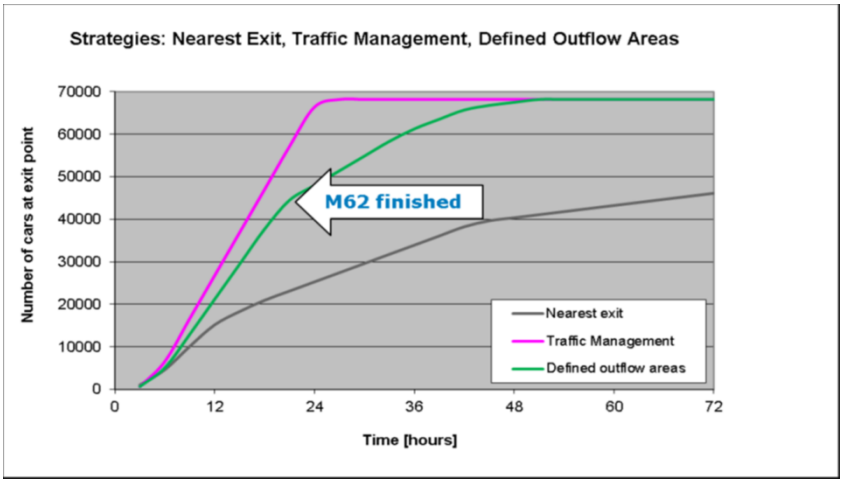
As part of the Government H19 assessments for the East Coast of England, a tiered modelling approach was used to investigate the requirements for mass evacuation in the event of a major storm surge, such as occurred in 1953 and 2013. This considered two study areas: Lincolnshire & Norfolk and Humberside. Three levels of modelling were used: a static, macro model (the Dutch *Evacuation Calculator)* to gain insight of the effectiveness of different strategies; a meso-dynamic model (OmniTrans) to identify local bottle necks in the road network; and an agent-based, micro model (Life Safety Model) to investigate individual people behaviour at the local or micro scale. This tiered approach provided detailed and valuable insight of the issues associated with data collection and the modelling assumptions, and how the uncertainties associated with these could be addressed.

Evacuation, considered in these two studies, involves the organisation of, and the movement of, (part of) the population to a (relatively) safe place in case of a threat of flooding. The overall time required for safe evacuation involves the departure time, the transit time along the designated routes, and the time to exit to a safe haven (see below). The modelling considered different assumptions concerning the time that people groups take to leave their homes, the allocation of travel routes, and the ease with which they are able to exit the designated route to a safe location. In terms of the allocation of travel routes, three options were considered: (nearest exit – where people choose the nearest route to their home; a designated set of start and end points; and 'traffic management' – which allocates vehicles to set routes based on knowledge of their capacity, which represents the optimal situation).

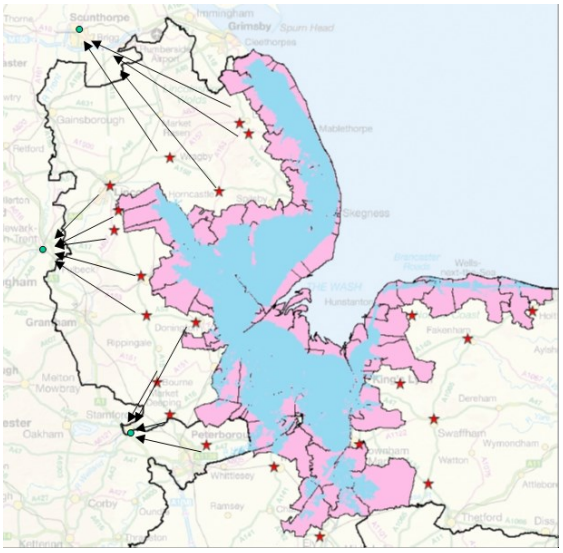


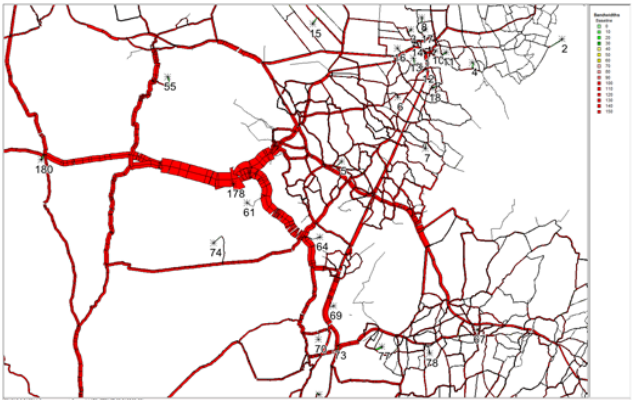
For the Humberside study, the macro and meso modelling showed that full evacuation was possible within 48 hours, as long as there was some form of emergency management (defined outflow areas or traffic management) – see opposite figure. The outflow rate at each exit point was important, which indicates that regional coordination



would be needed to ensure such a smooth operation. Interestingly, the Life Safety Model, which was the only approach to consider the local road network, showed that congestion north of the Humber on this part of the network was a problem, and could lead to overall travel times greater than 48 hours. Hence further investigation was probably needed to look at this in more detail, although this was not possible in the scope of the project.

For Lincolnshire & Norfolk similar results were obtained, with a total evacuation time of approximately 27 hours assuming an optimal use of the road network, which may not be a realistic assumption given normal driving behaviour. The following figures show firstly the location of the potential flood areas, and the assumed start and end points for journeys; and secondly an example of the output from the OmniTrans model and the predicted areas of congestion.





Consistent results were provided by the three modelling approaches, in terms of time needed for an evacuation, locations of major congestion, and optimal evacuation routes. However, these were sensitive to some of the assumptions, such as the size of affected population, ease of exiting onto the national network, and the ability to manage the allocation of traffic to certain routes.

In Lincolnshire, the study results have been used to identify 13 main evacuation routes designed to move people from the main coastal sectors to a point of safety. From these exit points, people will be advised to move to their location of choice or advised of available alternative accommodation. New signage of these routes has been provided which was supported by all resilience partners and local politicians. This has helped raise the profile of the threat and promoted some interesting engagement through local media and the public. The presentation will outline how use of the emergency evacuation routes is foreseen and the additional measures to be employed, such as provision of fuel and roadside assistance along the routes. Humber LFR also used the results of the study to define strategic evacuation routes but has not utilised dedicated signage along them.

Finally, the presentation will review the response to the December 2013 surge event relative to the study outputs, and the strengths of each model type. For example, the Meso model provides an overview of evacuation time and how traffic spreads over the network; the Meso model is also used to calibrate the Macro model. The macro model can be used for initial sensitivity analyses and problem scoping, as well as the role of uncertainties. Finally the Micro model can investigate the importance of local bottlenecks and can also be used to look at dynamic impacts as a flood wave interacts with the moving population, whether on foot, in cars or sheltering in situ.