Disappearing Traffic: can MATSim simulate travel behaviour during disruptive events?

ABSTRACT

The phenomenon of 'disappearing traffic' has been reported in the literature, with many examples of transport infrastructure loss leading to disappearance of previous transport journeys. As transport infrastructure ages, is affected by extreme weather conditions or is overused, its resilience decreases and its risk of damage increases. But what happens to the users of that infrastructure once it is no longer in service? Such events could impact travel demand, and as a cascading effect, the economy, society, and environment. On the contrary, users could find efficient detours with minimum impacts to the transport system, adapting their behaviours in the medium and long term. This abstract presents the results of a work-in-progress MATSim scenario, analysing the impact of the 4-year Tyne Bridge restoration work in the Tyne and Wear region (UK) and other associated infrastructure changes on travel demand. The consequences of reducing the maximum speed and traffic flow in the affected area are simulated to identify the agents' behavioural changes, and these are compared with observed traffic volumes on the regional road network. Alternative followed routes, increases in travel times and the effect of disappearing traffic are analysed to assess the model validation and the capability of MATSim to replicate these behaviours.

INTRODUCTION

'Disappearing traffic' has long been discussed, with Cairns et al. (2002) reporting numerous examples of the loss of overall traffic volumes due to reduce road capacity. They highlight that when "roadspace for cars is reduced, traffic problems are usually far less serious than predicted, overall traffic levels can reduce by significant amounts, and that traffic reduction is partly explained by recognising that people react to a change in road conditions in much more complex ways than has traditionally been assumed in traffic models" (ibid).

The Tyne Bridge is an important river crossing between the city of Newcastle upon Tyne and its neighbour Gateshead. It opened on 10th of October 1928 is used by over 70,000 vehicles daily (Newcastle City Council, 2024). In April 2024, rennovation work on the bridge began to address many decades of neglect, with serious repairs required to improve structural integrity, repair peeling paintwork, damaged deck joints, leaking drains and damage to the road surface (TyneBridge.org, 2025). As a result, the Tyne Bridge was reduced to half of its original capacity (i.e., from two lanes per direction to one lane per direction), affecting the flow capacity and the allowed maximum speed to one of the most highly-used bridges in the region.

METHODOLOGY

An existing validated MATSim model of the region (Alvarez Castro et al., 2024) was used as a baseline to represent the travel demand of a normal working day, where private (i.e., car), public (i.e., bus, rail, metro and ferry) and active (e.g., bicycle and walk) modes are simulated, using 20% population sample. For a detailed description of the model development, calibration and validation processes, see Alvarez Castro et al. (2024).

To simulate the impact in transport demand, network updates were made in those links related to the Tyne Bridge, reducing their capacity by half, from 4,000 to 2,000 vehicles per hour. Additionally, the maximum speed was reduced from 40 to 20 miles per hour, which was done in reality to protect the safety of construction workers and travellers. A 500-iteration simulation was run, where 30% of agents were randomly allowed to modify their plans in the first 80% of the iterations within the MATSim co-evolutionary algorithm (Axhausen et al., 2016) to avoid delays in their trips. 10% of agents were permitted to change transport mode (i.e., SubtourModeChoice strategy), 10% were allowed to change their routes (i.e., ReRoute strategy) and 10% could change the starting time of activities (i.e., TimeAllocationMutator strategy). The remaining agents used one of their previous saved plans in their memories, prioritising those with high score values (i.e., ChangeExpBeta strategy).

The results of the MATSim simulation were compared to data collected from the North East Transport Analysis Data Unit (TADU) for traffic sensors around the region. These sensors give hourly vehicle flows on major roads over the period of the Tyne Bridge restoration works, allowing a detailed comparison of the response of MATSim agents and the real response of road users in the study area. It was not possible to obtain bus ridership numbers or Metro station entries and exits, so understanding of real mode shit behaviour is limited.

RESULTS

Preliminary results show a general travel time increase through the Tyne Bridge, with a 400% increase in the morning and evening peaks in both travel directions (Figure 1 top right and top left), despite a reduction in the number of vehicles in those periods. The impact is greater when travelling northbound in the morning peak (Figure 1 bottom left), and southbound in the evening peak (Figure 1 bottom right).

Figure 1: travel time and vehicle count for the Tyne Bridge before (blue) and during (orange) the restoration works.

In total, 21% and 19% daily vehicle reductions are observed in the Tyne Bridge when travelling northbound and southbound, respectively. Consequently, fewer vehicles use roads leading to it (e.g., A184 (9% reduction), A167 (20%), B1318 (6%)). Alternatively, they choose other routes to reach their destinations, with increases observed on the Redheugh Bridge (11% increase), Tyne Tunnel (7%) and A1 Western Bypass (9%), as shown in Figure 2. These adapted behaviours align with the recommendations to avoid disruption during the bridge works made by the local authorities in most of the cases, although some recommended diversions were not prioritised by agents (e.g., Scotswood Bridge) (TyneBridge.org, 2025).

An increased number of vehicles on the diversionary routes does not, however, mean new traffic congestion or significant travel delays. The average travel time increase for those using the main detour roads is small: those individuals using the Redheugh Bridge face a 7-minute delay when travelling northbound and 1-minute delay when travelling southbound. In the case of the Scotswood Bridge, only a 2-minute delay is observed travelling northbound with no significant difference when travelling southbound. Similarly, those travelling through the Tyne Tunnel experience a 1-minute delay when travelling northbound and below a minute when travelling southbound. This suggests that the detoured routes can absorb parts of the traffic previously passing through the Tyne Bridge.

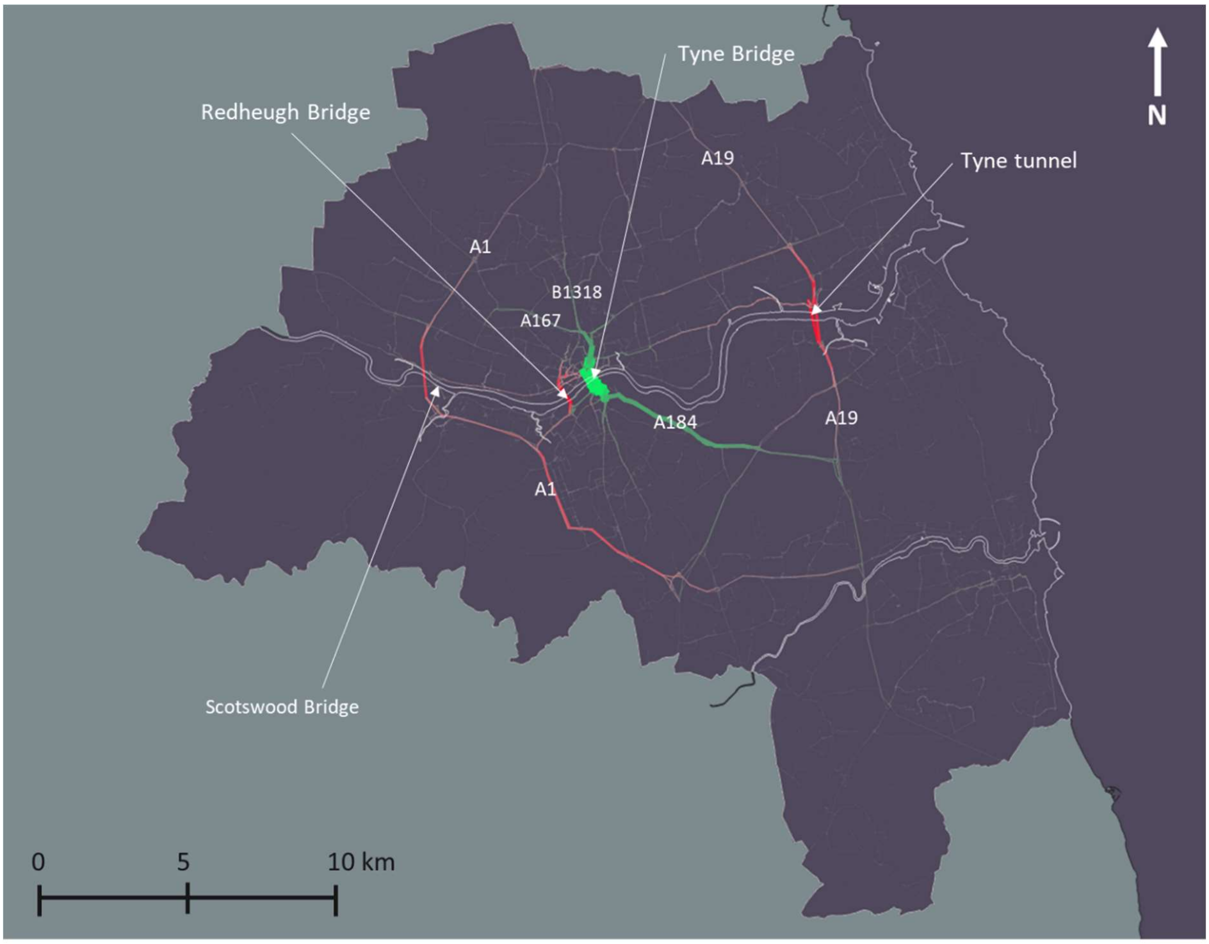

Figure 2: difference in vehicle flows for roads in Tyne and Wear between the baseline and the Tyne Bridge restoration scenario, showing roads with fewer vehicles during the scenario in green, and roads with more vehicles in red.

DISCUSSION

Work is now underway, and will be presented at the MATSim User Meeting, to compare the modelled vehicle flows with the observed data from TADU to test how close the simulation results are to reality. This will reveal whether the disappearing traffic phenomenon is observed in Tyneside and how closely MATSim is able to capture that behaviour. This will be supported by further analysis in MATSim, as more iterations are required to reach an equilibrium point where agents can no longer improve their performance.

Eventually, these results will be used as part of the DARe Hub (Decarbonised, Adaptable, and Resilience transport infrastructure) to explore the resilience of the transport system in the Tyne and Wear region. Transport resilience is a fundamental component of society and will be stretched further with ageing infrastructure and increased future extreme weather events under climate change.

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ACKNOWLEDGEMENTS

This work has been funded by the Engineering and Physical Sciences Research Council and UK Department for Transport, Grant Reference EP/Y024257/1.