Transportation Research and Injury Prevention Centre

Indian Institute of Technology Delhi

TRAFFIC SIMULATION FOR NATURAL DISASTER PREPAREDNESS

CASE STUDY OF DADAR, MUMBAI

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Overview

Background

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Background

- Urban flooding has become increasingly frequent and severe, disrupting the lives of millions of people.

High Rainfall Frequency + High Population Density + Poor Drainage →

Disconnectivity

Emergency Facilities

Uninhabitable

Mass Evacuation

Frequency of disasters increased by

200% since 2005

17 out of **20**

People in India are exposed to hydro-met Disasters

In flood vulnerability, Mumbai ranks

2nd

among million plus population cities

Source: CEEW, 2021. Mapping India's Climate Vulnerability : A District Level

Background

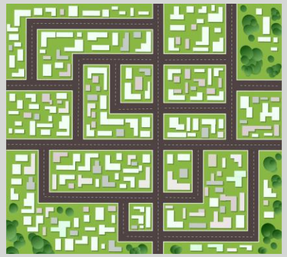
- Traffic simulation models are capable to mimic the real-life traffic performance and travel patterns.

Simulation Model Use Case

Congestion

Emissions

Road Safety



Network Planning

Evacuation Planning

Simulation Resolution

Macroscopic

Mesoscopic

Microscopic

Research Gaps

01 No background demand considered in the simulation, leading to improper representation of traffic condition.

02 No study has analysed road network vulnerability and different evacuation strategies under heterogeneous traffic conditions.

03 Existing contraflow strategies utilised have been limited to corridor-level evacuation models.

04 Staged evacuation have focussed on determining the optimum staging strategy without application of simulation models

Objectives

This study is a Proof of Concept (POC) aimed at:

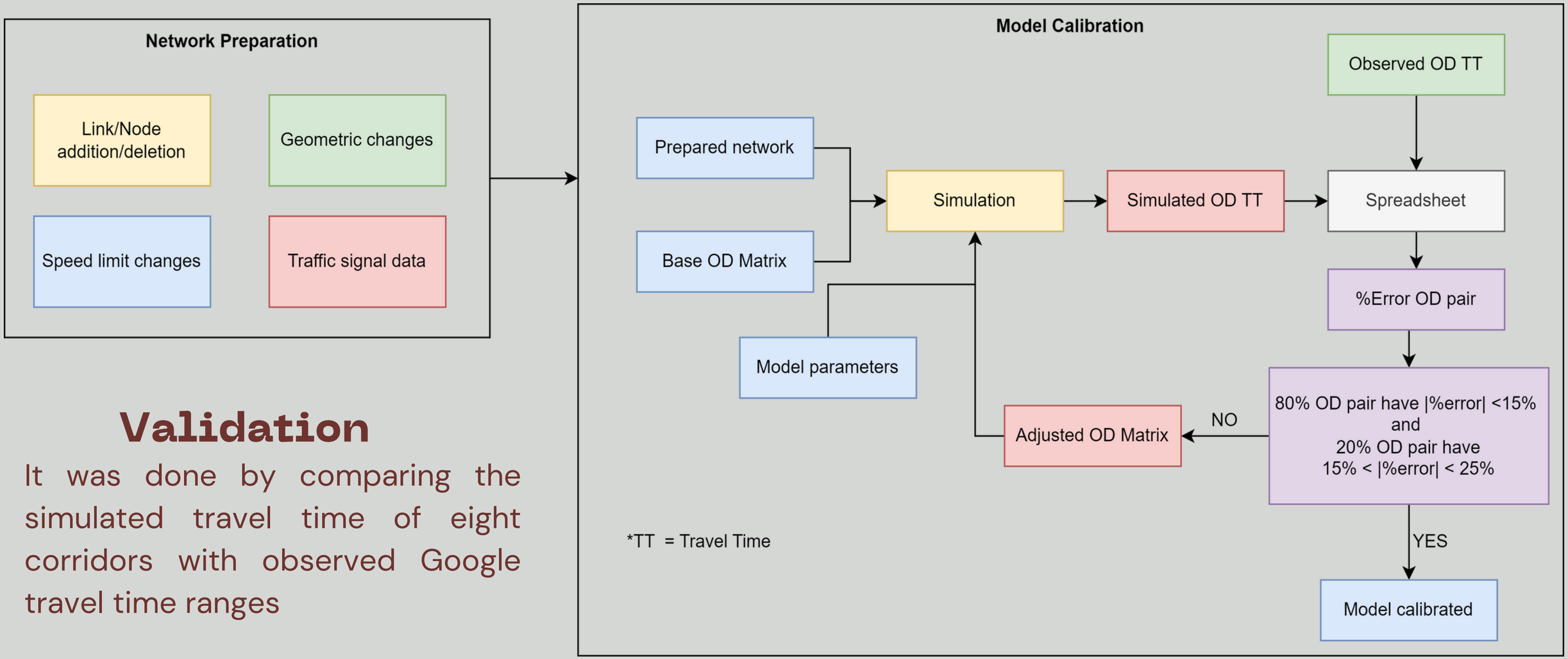
Objective 01

To assess the vulnerability of the road network against different disruptions.

Objective 02

To assess the impact of different evacuation strategies on the evacuation time.

Methodology



Validation

It was done by comparing the simulated travel time of eight corridors with observed Google travel time ranges

Methodology

Vulnerability Scenarios

01 Roads along Worli-Sea Face area are assumed to have got inundated leading to the reduction of speed to 50% of the original speed limit.

02 Based on the frequent waterlogged points, the roads within 300m of these locations are disconnected from the network.

Evacuation Scenarios

03 The entire population form all the zones is assumed to evacuate in 3 hours using private vehicles.

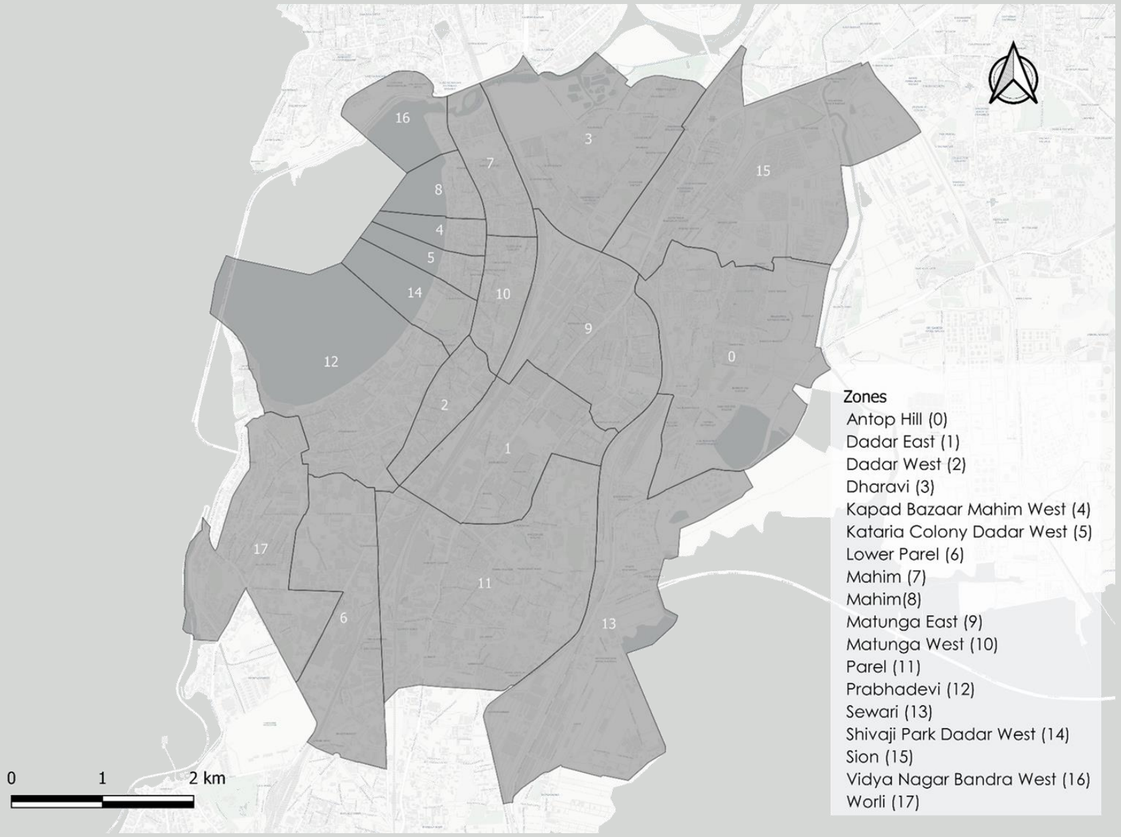
04 The demand remains same as scenario-3, however capacity of the roads leading to safe zones is increased by one lane, and opposing roads is reduced by blocking one lane.

05 The demand from different zones is released in three stages. In each stage traffic demand from three or four zones is evacuated to the safe zones.

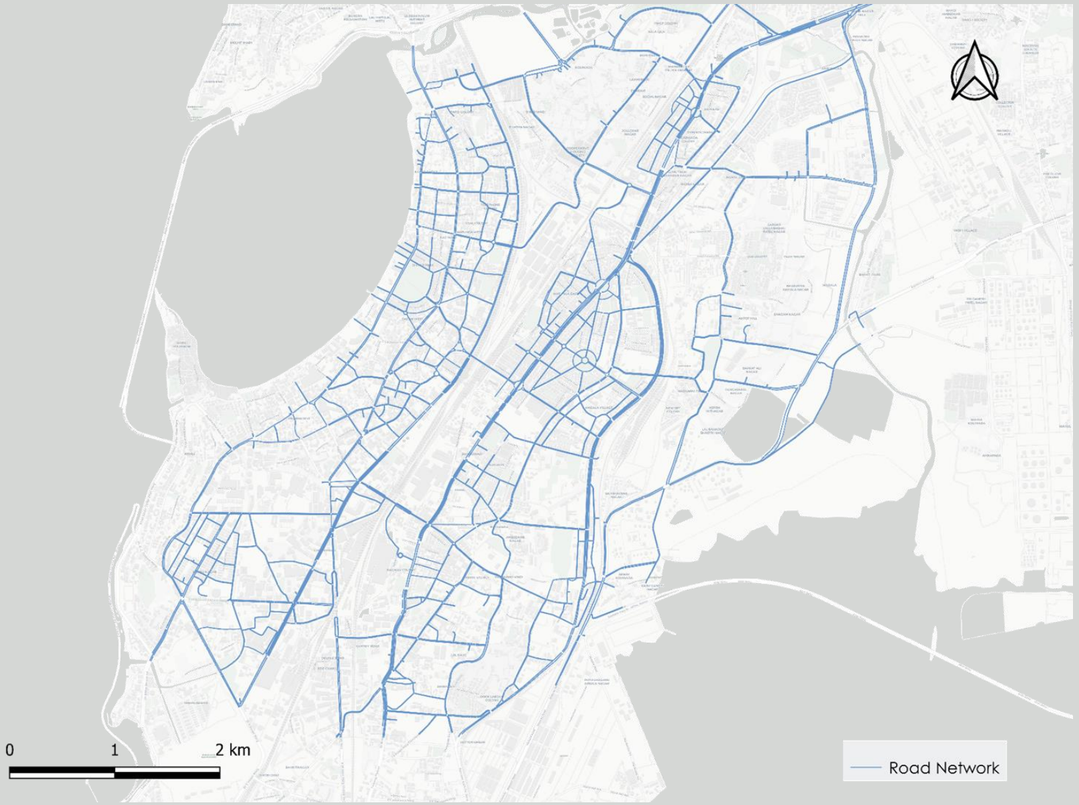
06 This scenario is a combination of Scenario-4 and Scenario-5.

Study Area

Zones



Road Network



18 zones

5159 road links

2147 nodes

6183km of road length

Results–Base Model

Calibration

49,308 trips

43,841 Completed

91.52 sec/km

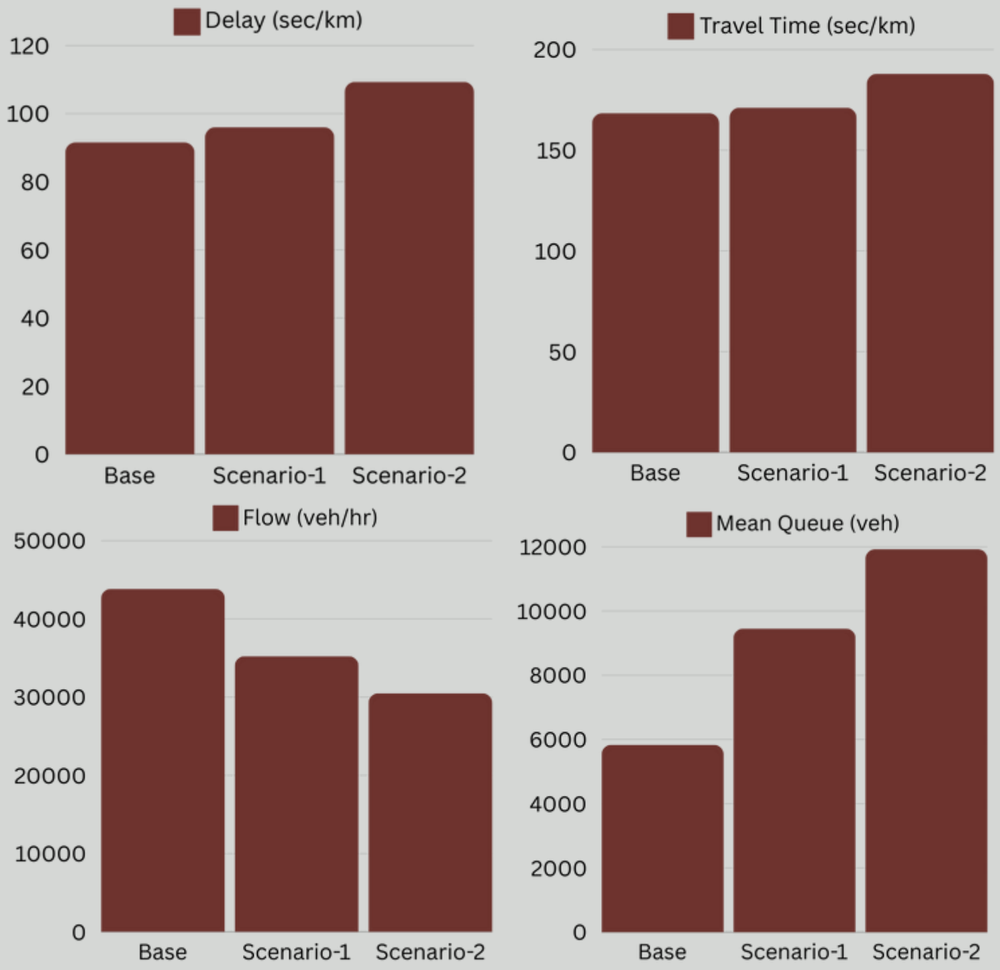
11.93 Veh/km

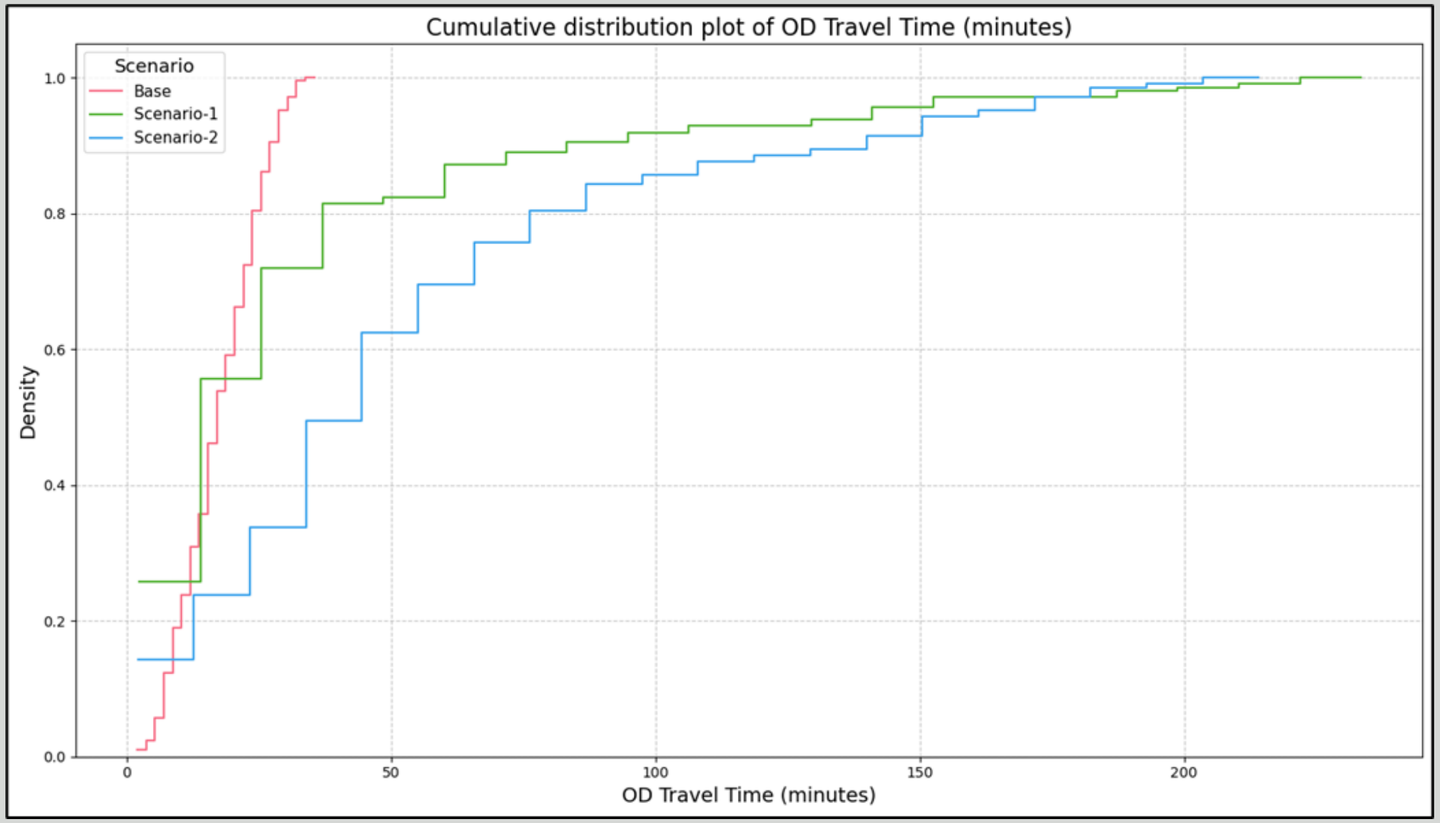
26.08 km/hr

Validation

Corridors	Length	Simulated TT (minutes)	Observed TT (minutes)	
Dadar East–Sion Koliwada	2.7	4.41	4	8
Dadar–Dharavi	3.4	7.61	7	18
Dharavi–Dadar	3.4	8.16	8	16
Mahim–Worli sea face	2.3	11.2	5	12
Shivaji Park–Qadri Masjid	2.2	9.72	7	16
Qadri Masjid–Shivaji Park	2.3	10.2	6	12
Sion Koliwada–Dadar East	3.8	7.07	5	9
Worli Sea face–Mahim	3.2	13.85	6	16

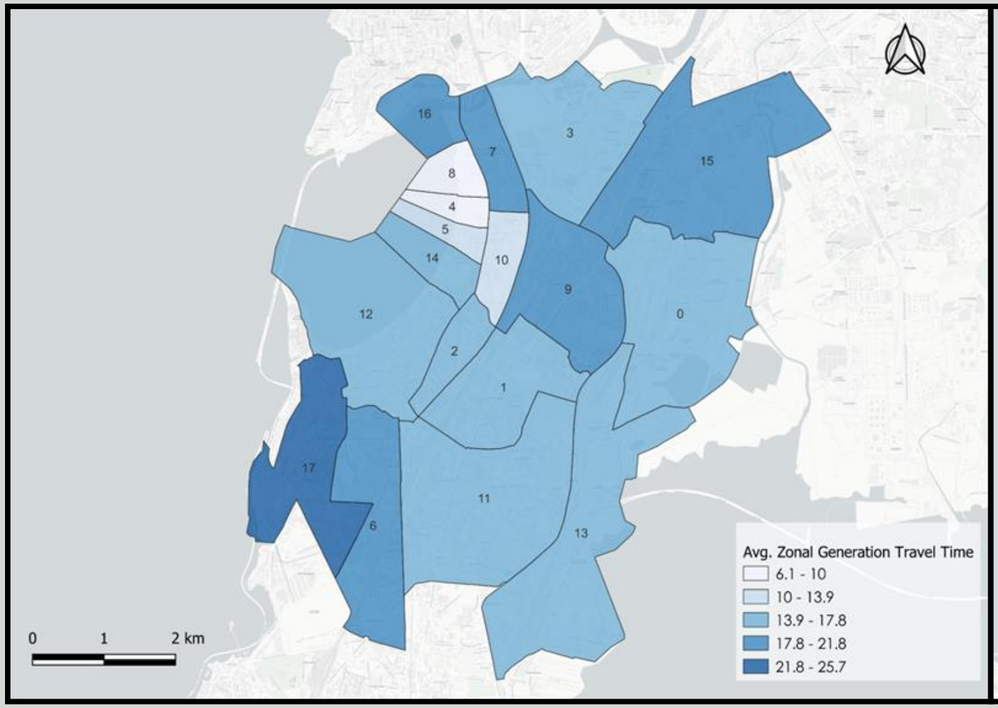
Results

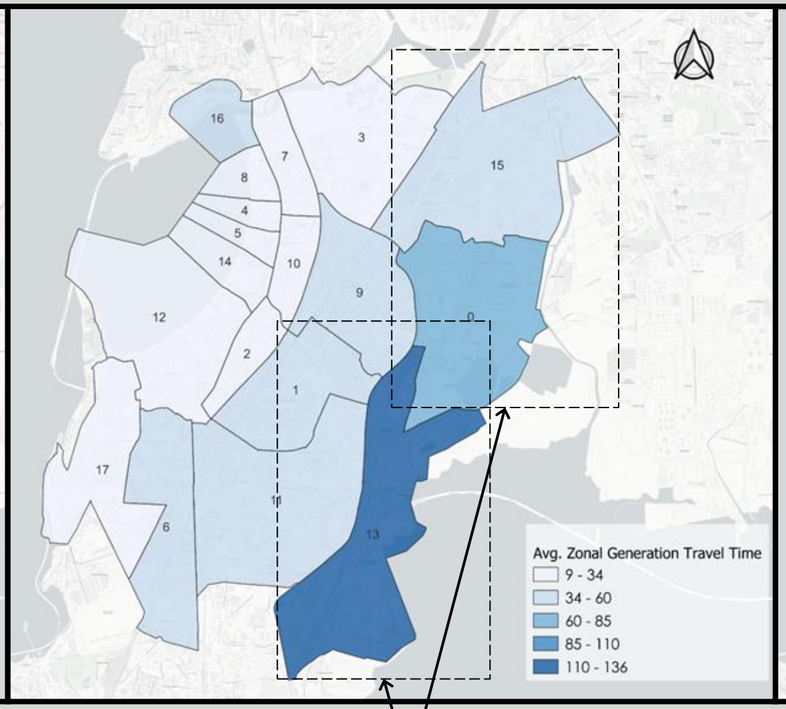


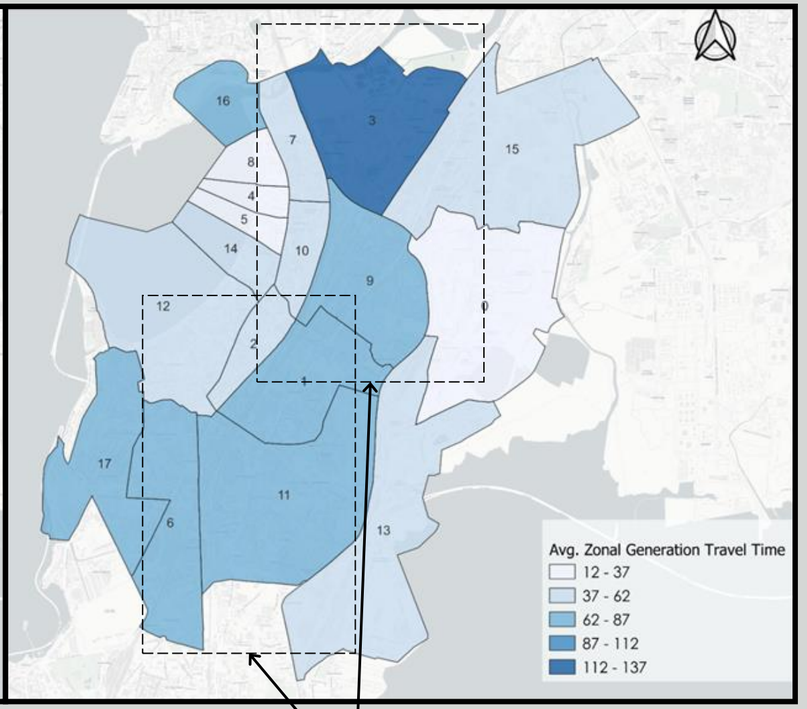


- Scenario-1 has lower impact on OD travel time than scenario-2, as only 30% of the OD pairs have a travel time higher than 25 minutes.
- Scenario-2 had a delay time of 109 sec/km, significantly higher than the base and scenario-1.
- In Scenario-2, 65% of the OD pairs have a travel time greater than 25 minutes.

Results



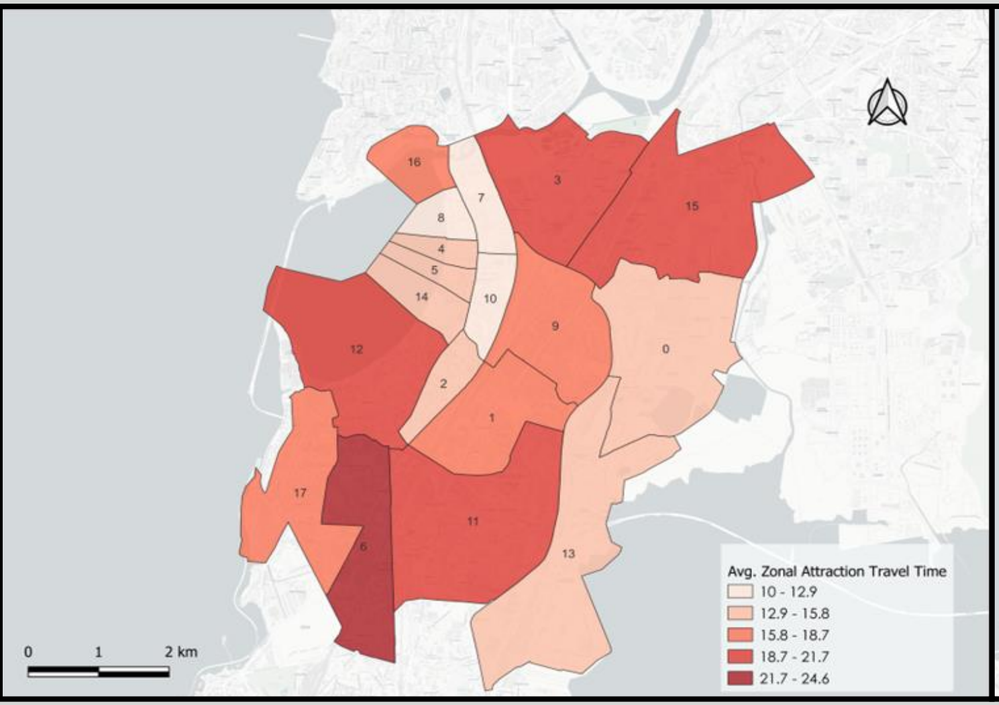


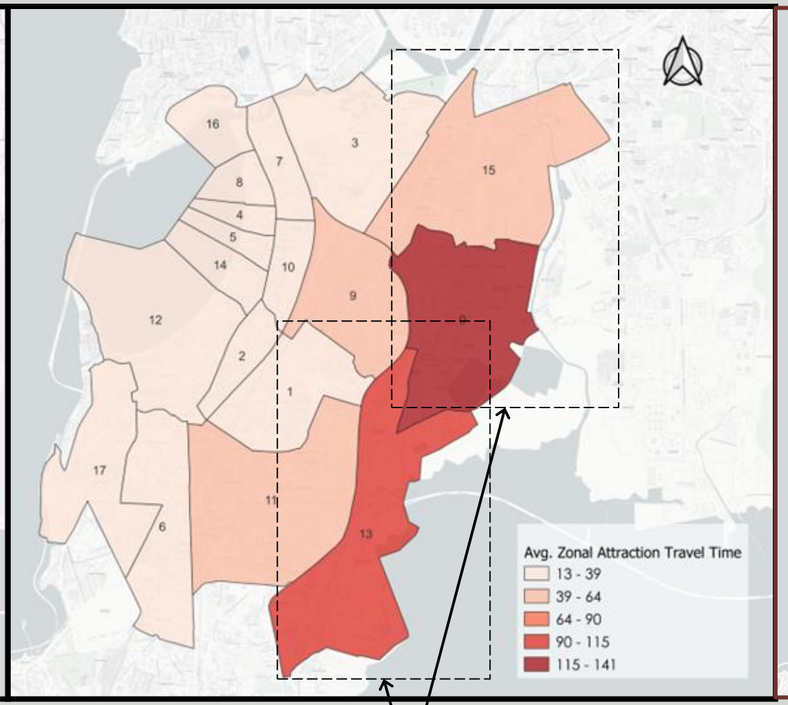


Zones away from the affected area are suffering higher trip generation travel time.

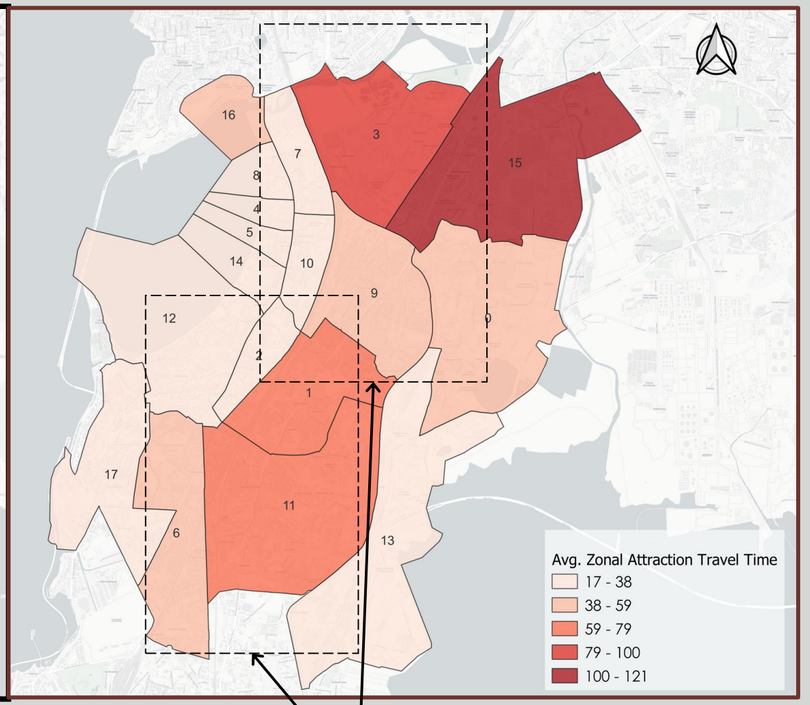
Zones near the affected area are suffering higher trip generation travel time

Results



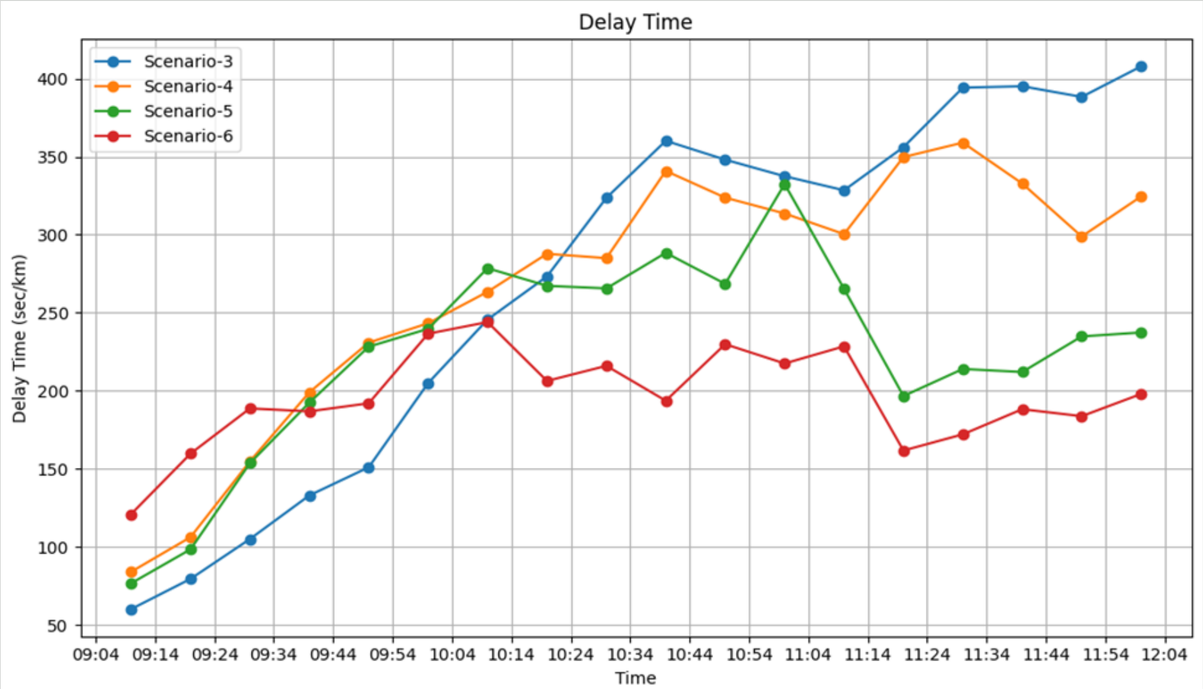


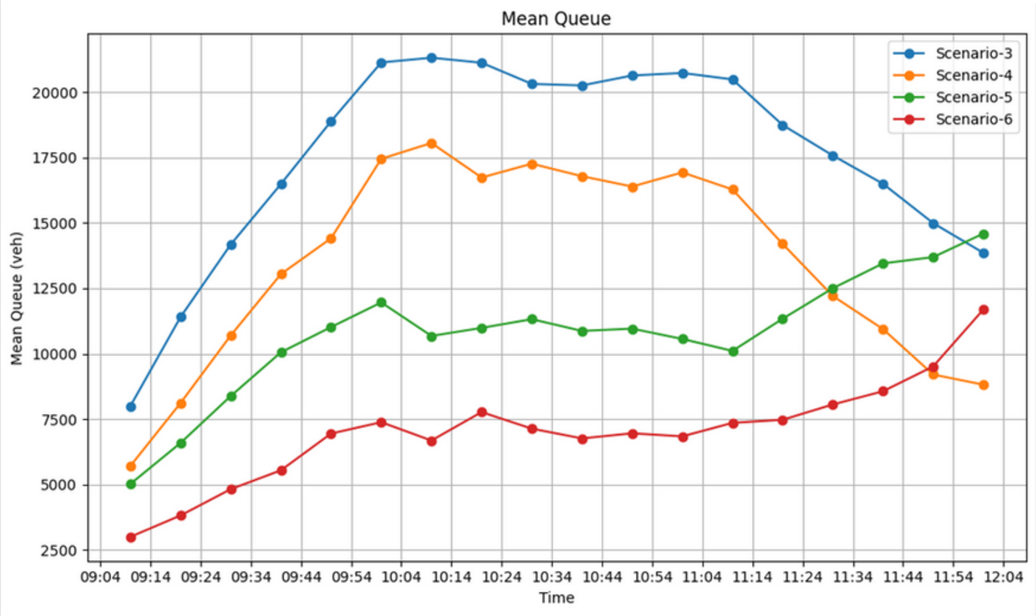
Zones away from the affected area are suffering higher trip attraction travel time.

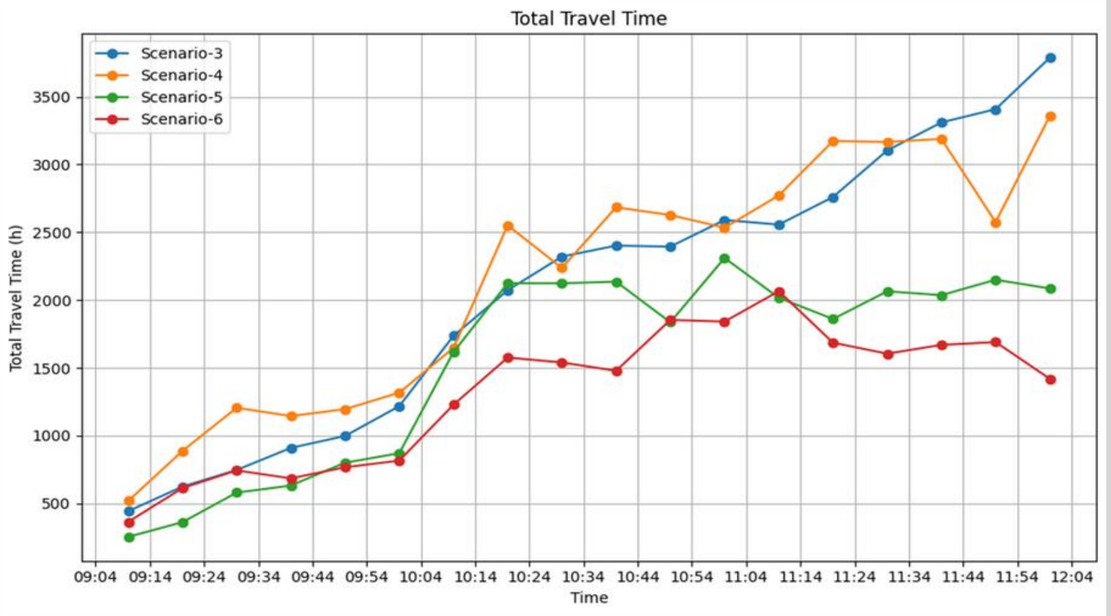


Zones near the affected area are suffering higher trip attraction travel time

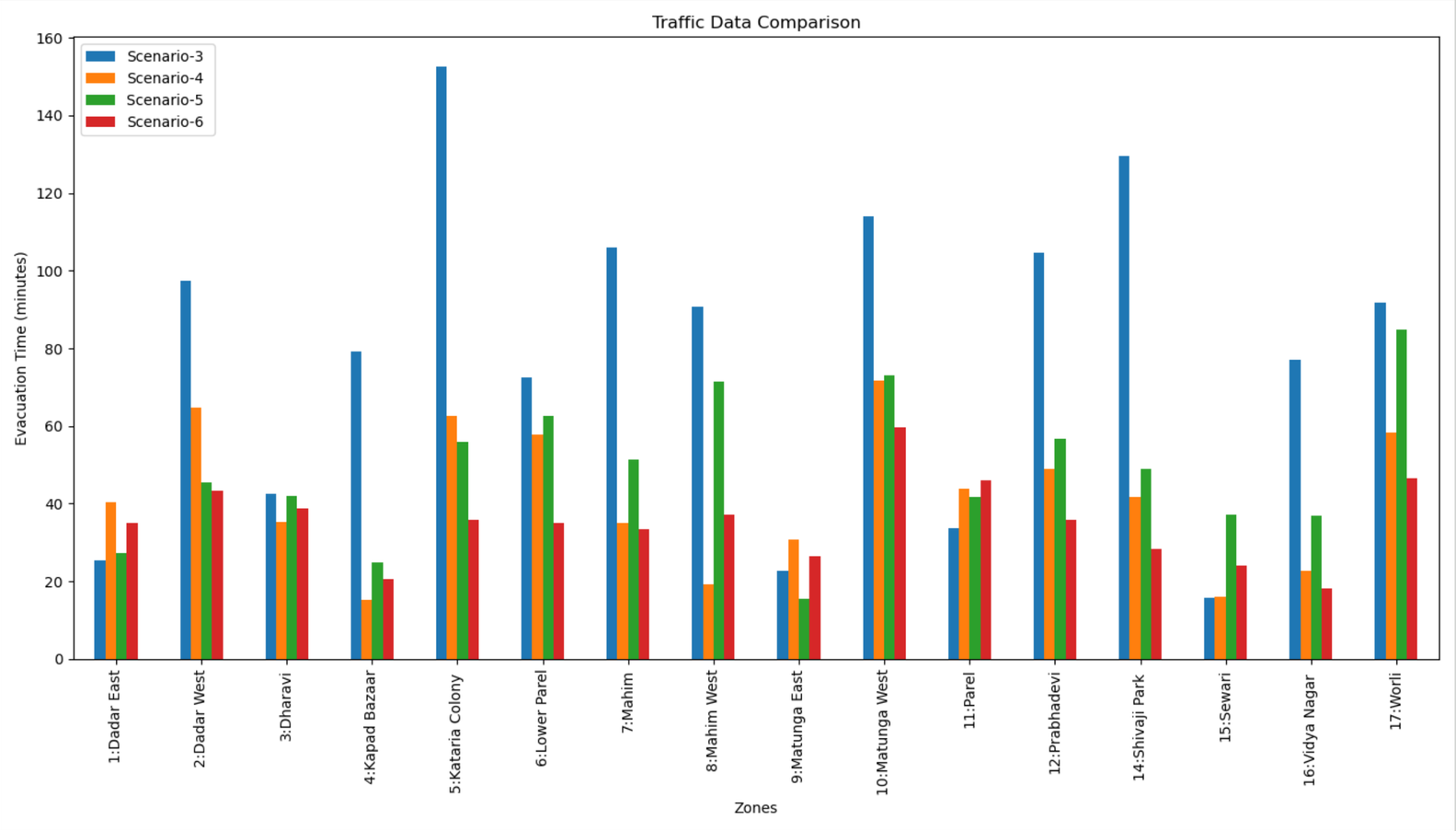
Results


Delay Time
Scenario-3
Scenario-4
Scenario-5
Scenario-6
Delay Time (sec/km)
Time


Mean Queue
Scenario-3
Scenario-4
Scenario-5
Scenario-6
Mean Queue (veh)
Time


Total Travel Time
Scenario-3
Scenario-4
Scenario-5
Scenario-6
Total Travel Time (h)
Time

Results



- Scenario-6 performs better and has minimum evacuation time for nearly 50% of the zones,
- Scenario-3 performs the worst with, evacuation time for zone 5 being more than two hours, which is three times of the scenario-6.
- Staging plus contraflow scenario can allow for 2x to 3x lower evacuation times than scenario-3 for certain OD pairs.

Conclusions

01 Disconnectivity of multiple intersections can lead to severe reduction in performance as compared to water inundation scenario.

02 Mass evacuation without any strategy or traffic management measure leads to higher evacuation travel time.

03 Contraflow and staged evacuation can help improve the evacuation time for all the zones.

04 Traffic simulation models can enable disaster management authorities pinpoint severely impacted areas during disaster.

05 Traffic simulation models can allow for the evaluating different evacuation strategies.

Limitations

Public transportation has not been considered when calibrating the road network, and the driver behaviour used in the model is suitable for daily conditions only.

Future Work

- Considering the role of public transport in calibration and evacuation strategies.
- Applying optimisation-based methods to identify the optimal zonal staging configurations.

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THANK YOU!

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