ADVANCED MULTI-HAZARD RISK ASSESSMENTS OF TRANSPORT NETWORKS

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ADB

Agenda

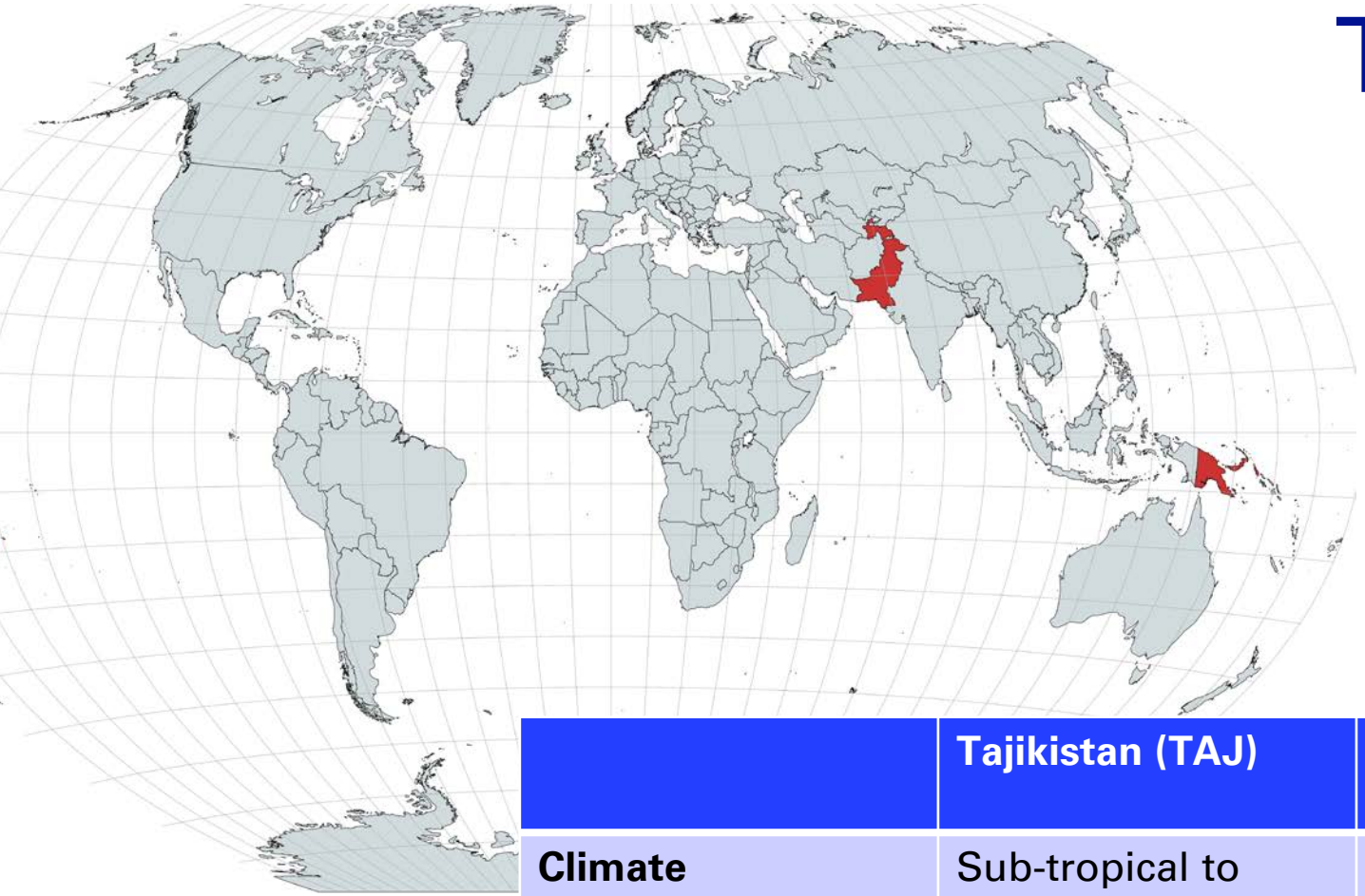
- Why the Project?
- Model Overview
- Traffic Model Development
- Hazard Modelling
- Outputs
- Summary

Why the Project

Source: Asian Development Bank

- Transport systems in Asia and the Pacific are vulnerable to climate change-related hazards.
  - direct damage to infrastructure
  - disruption to transport services
  - and wider social and economic impacts
- Emerging economies in Asia and the Pacific face a growing transport infrastructure gap.
  - estimated at US$2.9 trillion by 2035, comprising $2 trillion for new transport infrastructure, $0.2 trillion for climate-proofing and $0.7 trillion for maintenance.
- Climate-related hazards **account for 65% of annual damage to transport infrastructure** in the region.
- ADB desire to deliver ‘Type 2’ projects = Climate Financing

Three Countries



	Tajikistan (TAJ)	Pakistan (PAK)	Papua New Guinea (PNG)
Climate	Sub-tropical to semi-arid	Arid with monsoon rains	Tropical
Major Hazards	Floods, landslides	Flooding, Earthquakes	Flooding, landslides
Population	75 /km^2	335 /km^2	25 /km^2
Road Network	Limited	Extensive	Disconnected

THE MODEL

Multiple Hazard Database Task 1

Hazard footprint

Asset-Level Exposure & Risk Task 1

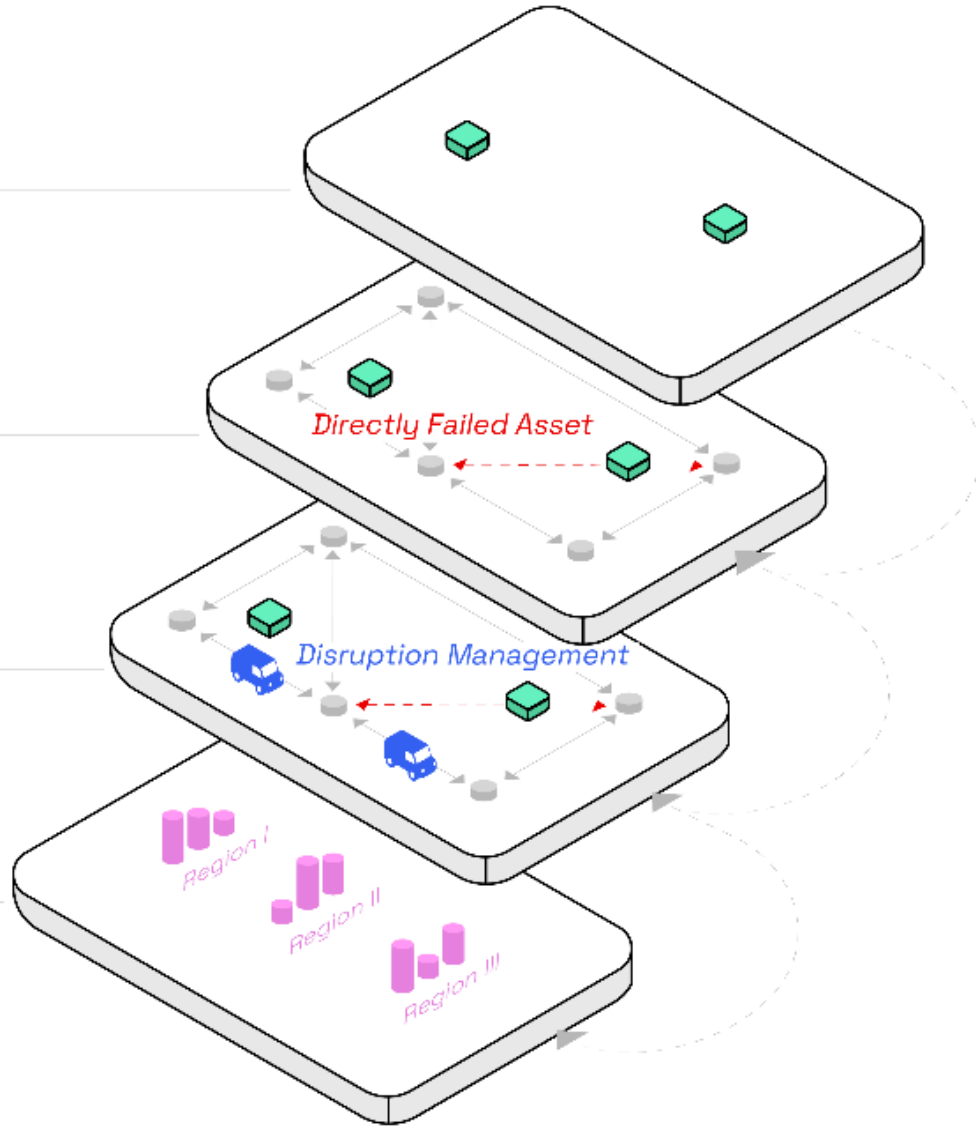
Origin/Destination

Network Criticality Analysis Task 2

Infrastructure Services

Economic Losses & Risk Task 2

Regional loss metrics

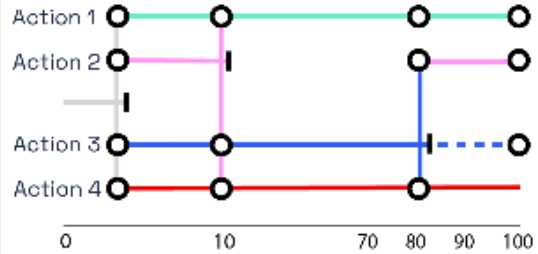


Adaptation Strategies Task 3

Asset-level strategies

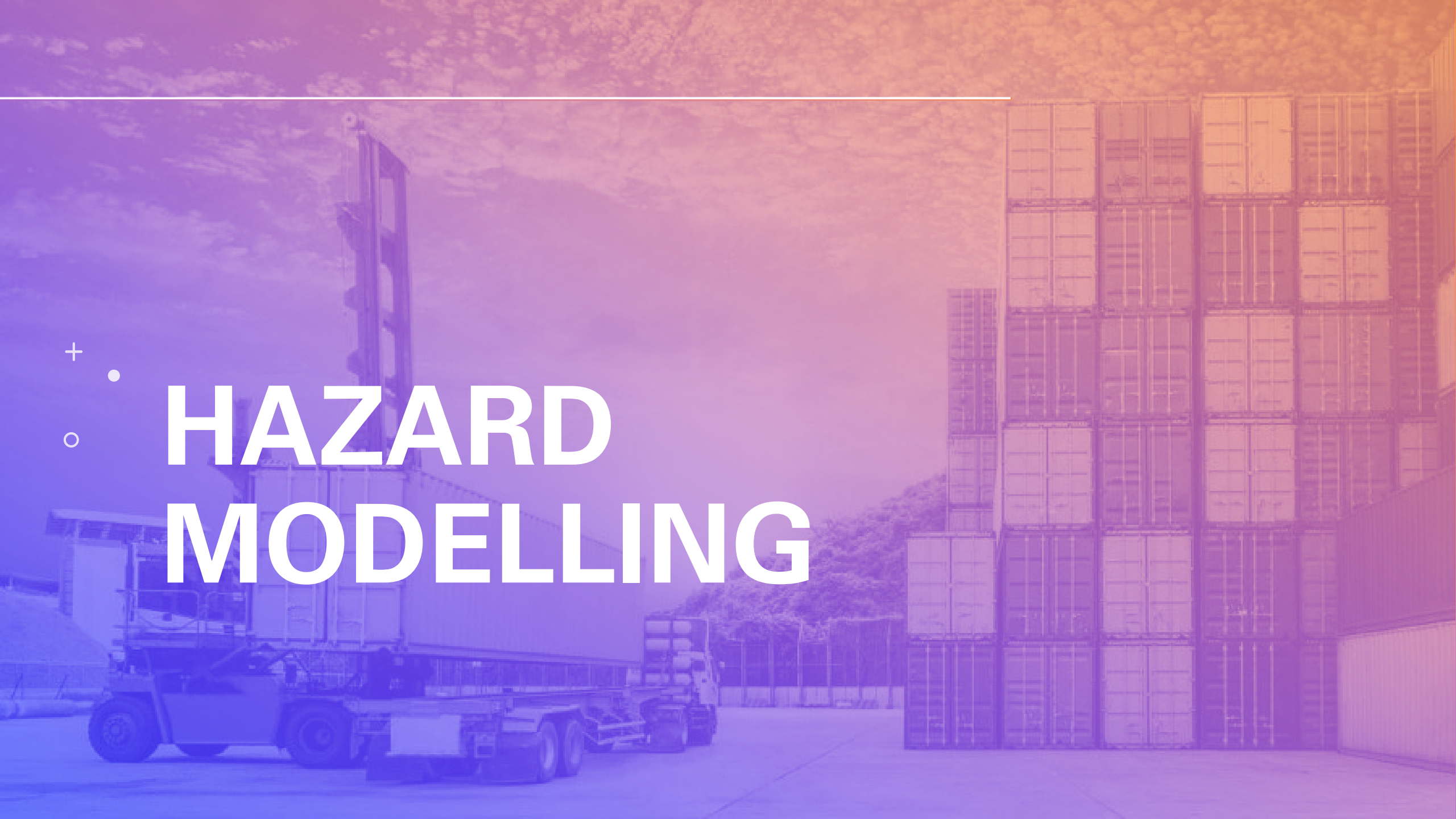
System-level strategies

Network-level strategies

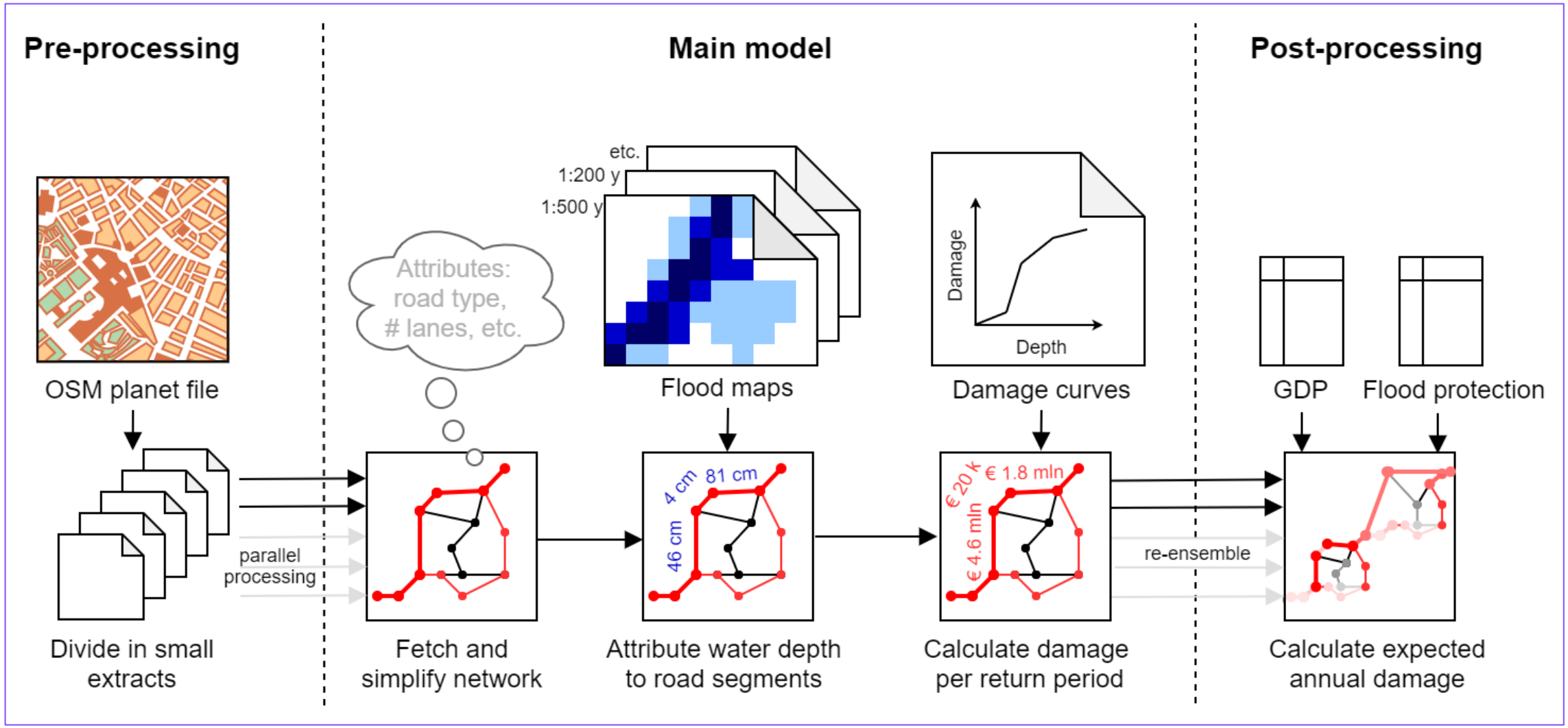


Investment decisions

Source: E.Koks



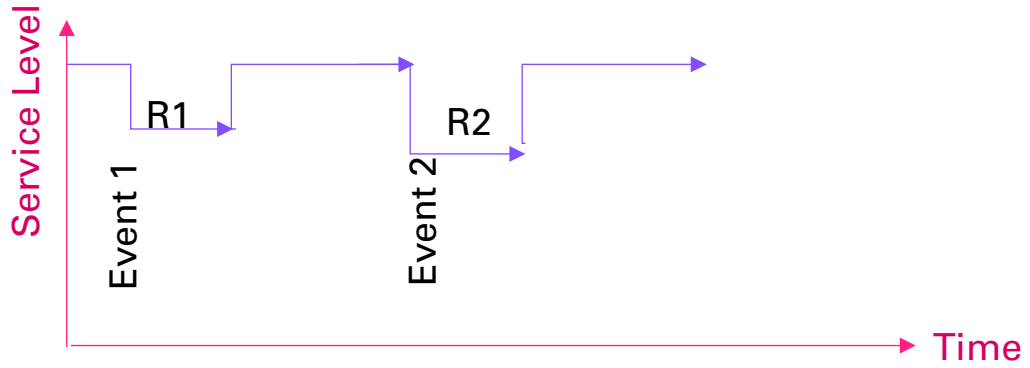
HAZARD MODELLING



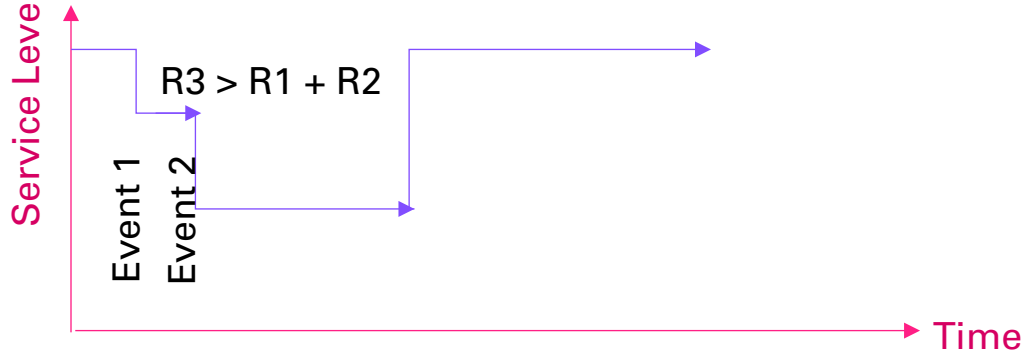
Source: E.Koks

Event Modelling Capability

- Critical event is often the second one
  - E.g The repeated flood events in the Tasman-Nelson-Marlborough area during the winter of 2025

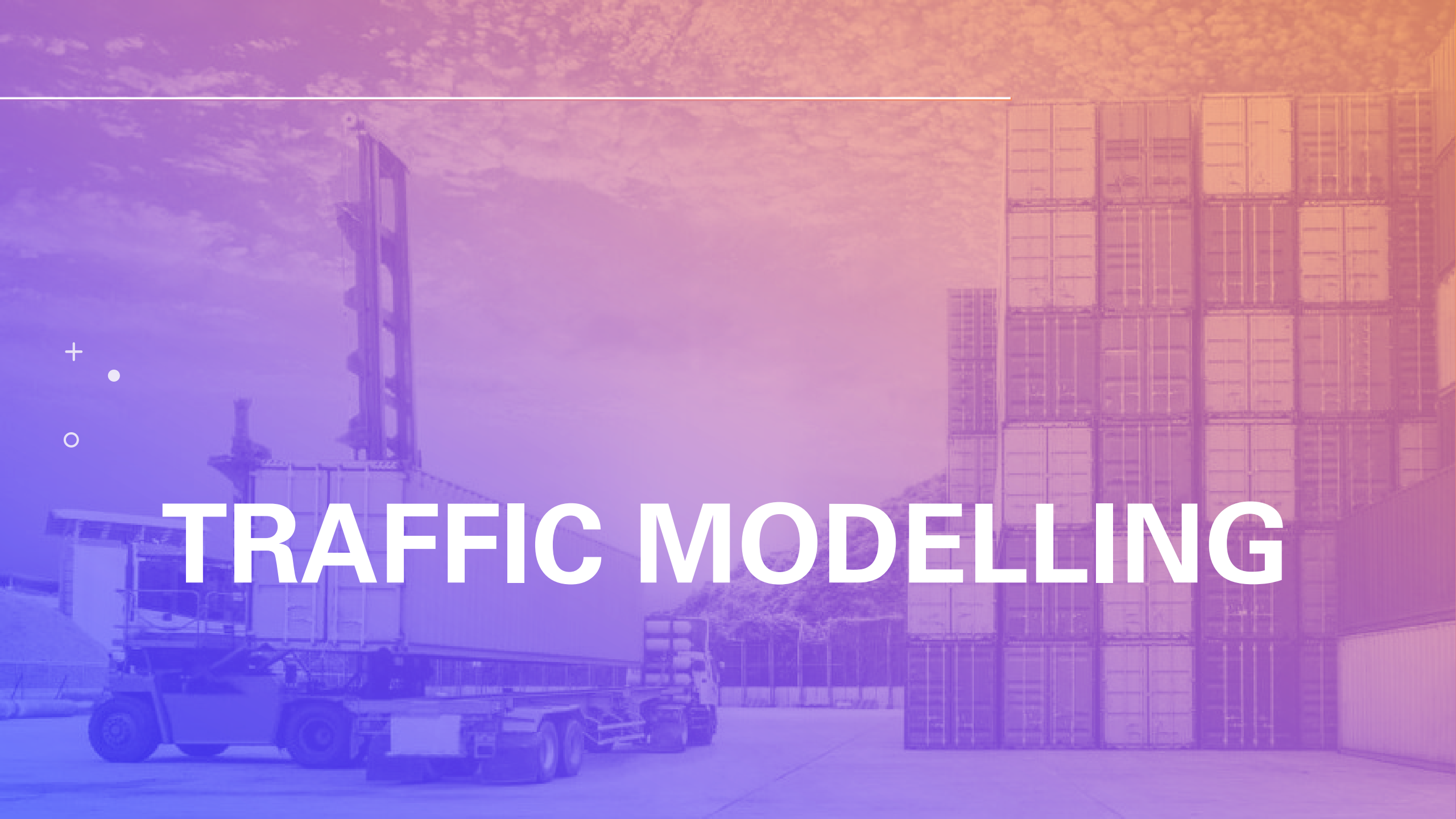


- Network interdependencies
  - A substation is flooded/hit by an earthquake, but the transport hub is not → still no functioning transport hub
  - They might be affected at the same time, but the substation is taking longer to recover/was more severely affected → still no functioning transport hub.



Data Sets

- JBA Flood Data
  - Whole world at 30m grids (moving to 3m grids)
  - Pluvial and fluvial flooding
  - 1 in 20, to 1 in 1500 year events obtained
  - Overlaid with multiple climate change prediction models
- Earthquakes
  - Global data set of events
- Landslides
  - Modelled from terrain/geology/rainfall, and (where available) local data sets
- Liquefaction
  - Coalition for Disaster Resilient Infrastructure (CDRI)



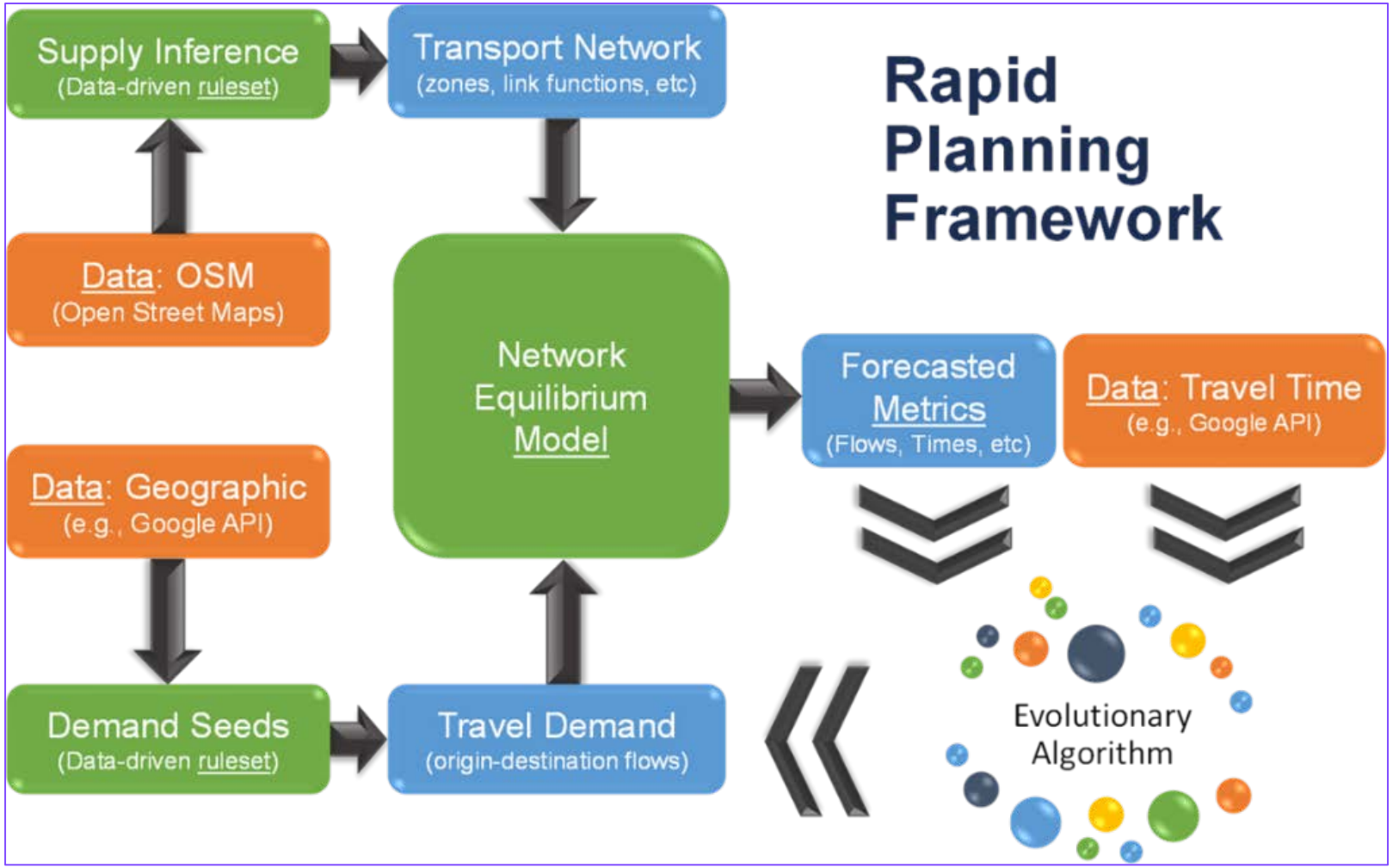
TRAFFIC MODELLING

Road Network:
Road authority & Open Street Maps (OSM)

Traffic Data:
AADT from road authority TomTom and Google

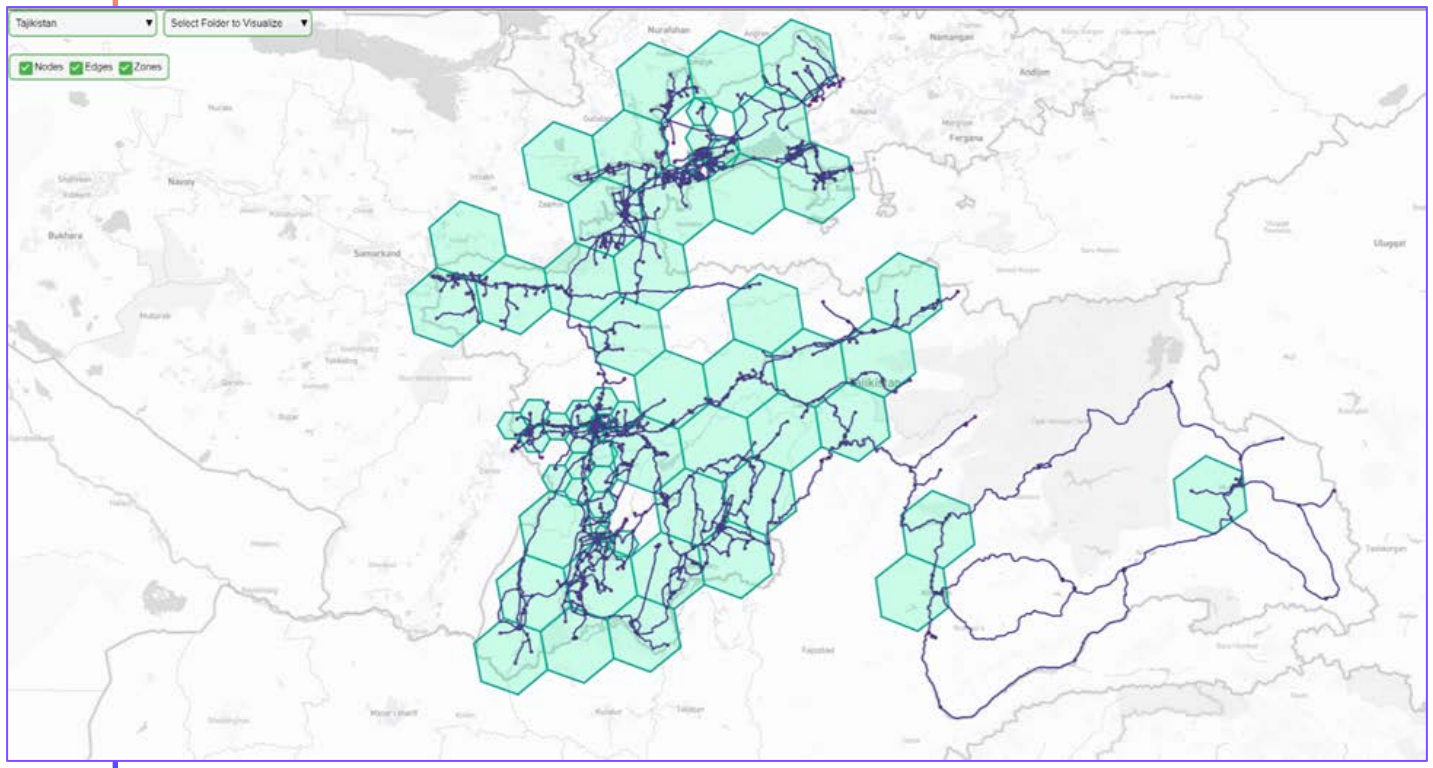
POI:
dataplor, Safegraph and Google

Population data:
WorldPop



Source: T. Waller

O-D Zone Structure (TAJ)



- 7,660 edges, covering a total of 20,566 km.

- 70 zones, with zone sizes based on the Uber H3 spatial indexing system.
  - 1,770 km² at resolution 4
  - 253 km² at resolution 5
  - 36 km² at resolution 6

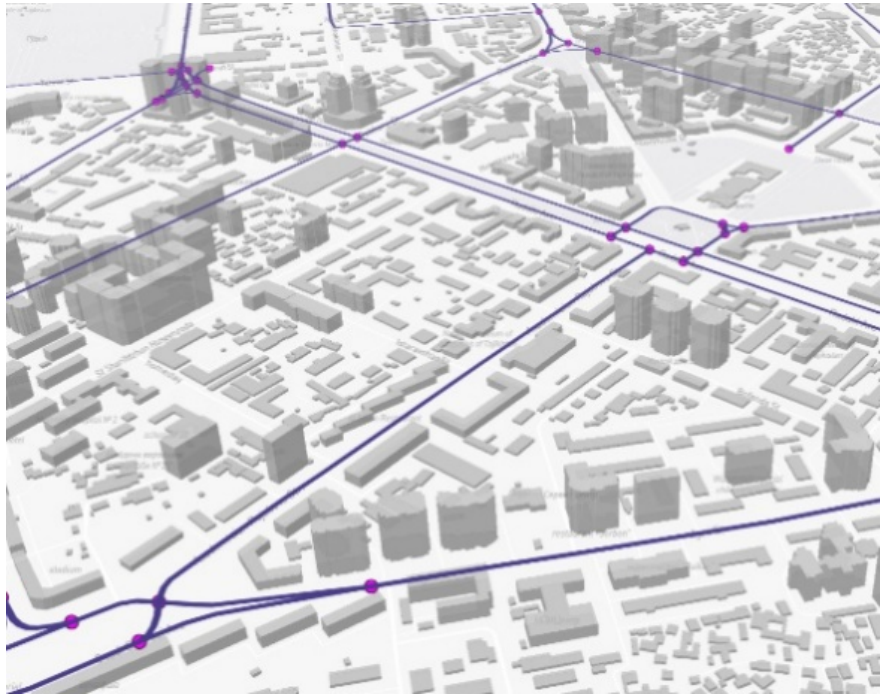
The total VKT in the model is 56,593,963 km per day.

The total Travel Time in the model is 1,856,842 veh-hr/day.

TAJ Model Results

VKT_Estimated (for observed links)	4,499,025 km
VKT_Observed (for observed links)	4,489,053 km
Percentage .Diff	0.22 %
Percentage .Diff for Total Travel Time	6.65 %
Percentage .Diff for Total (Travel Time * distance)	0.32 %

Classification	Estimated_AADT	Observed_AADT	AADT_Percent_diff
trunk	8478	7894	7.4%
primary	4526	4591	-1.42 %
secondary	2759	3181	-13.27%

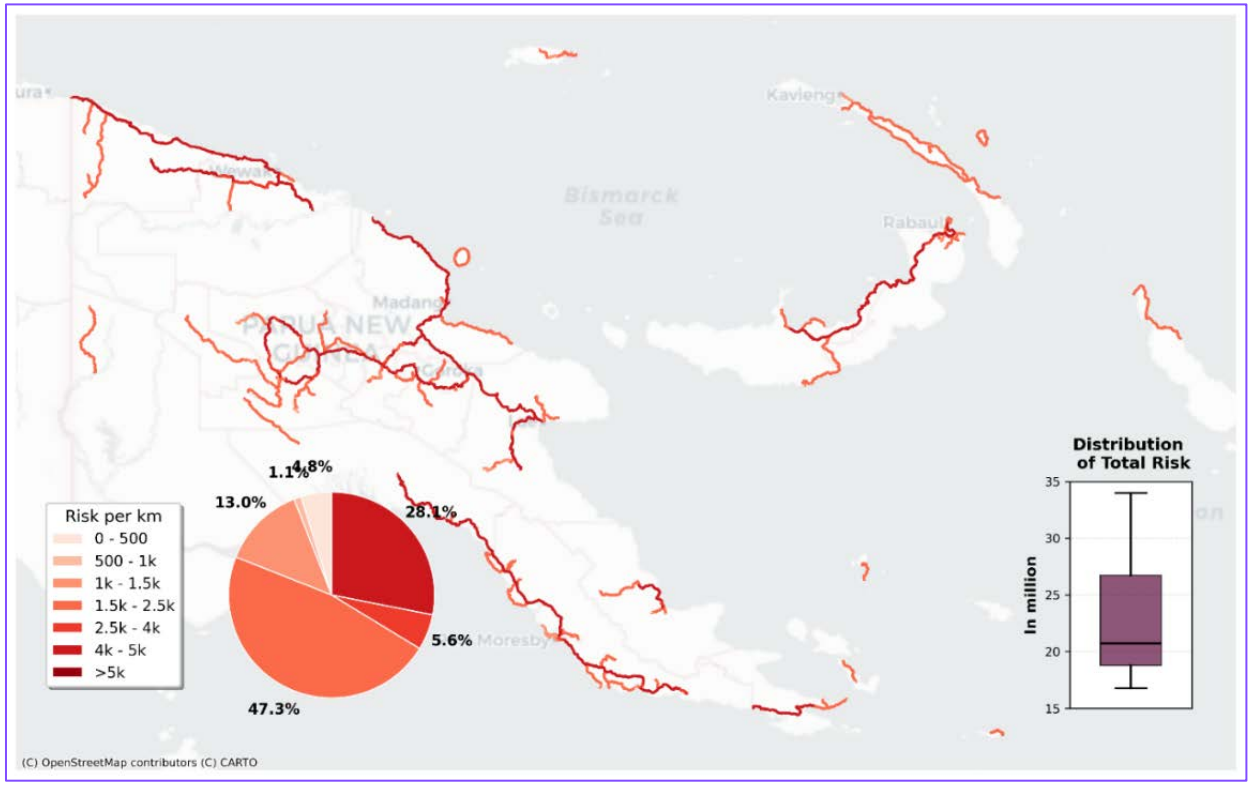


What About Pedestrians

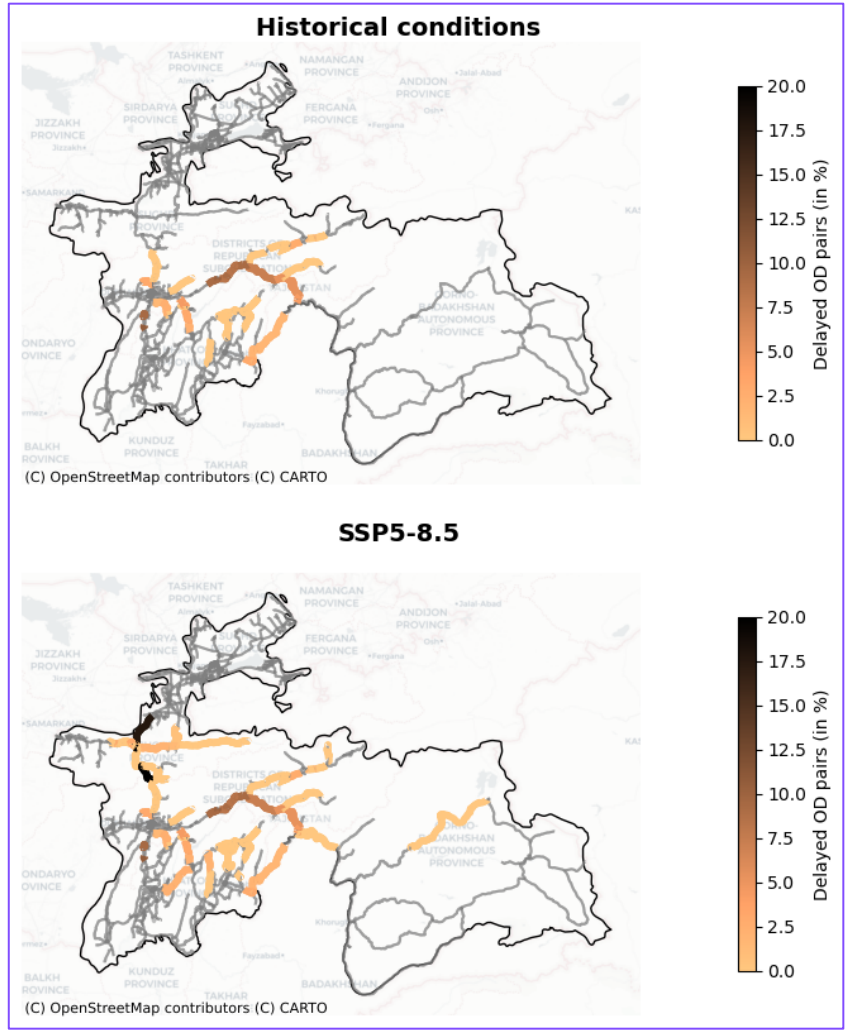
- For national level resilience studies, pedestrians are not a significant component of transport demand for long distance trips (can make a up a large portion of intrazonal trips)
- But we have evolved the transport model to now model pedestrian flows and linkages at the local level when using smaller zones
- Can see how adding pedestrian linkages can improve resilience across the network
- Also identifies what risks pedestrian routes are exposed to.

OUTPUTS

Network Level



PNG Earthquake Risks



% Delayed OD Pairs
Due to a 1/10 landslide event
triggered by a 1/200 rainfall event

Project Level

Ready assessment of specific corridors

What are the risks at each location along the corridor?

What level of resilience is justified?

What are the economic impacts of differing levels of resilience?

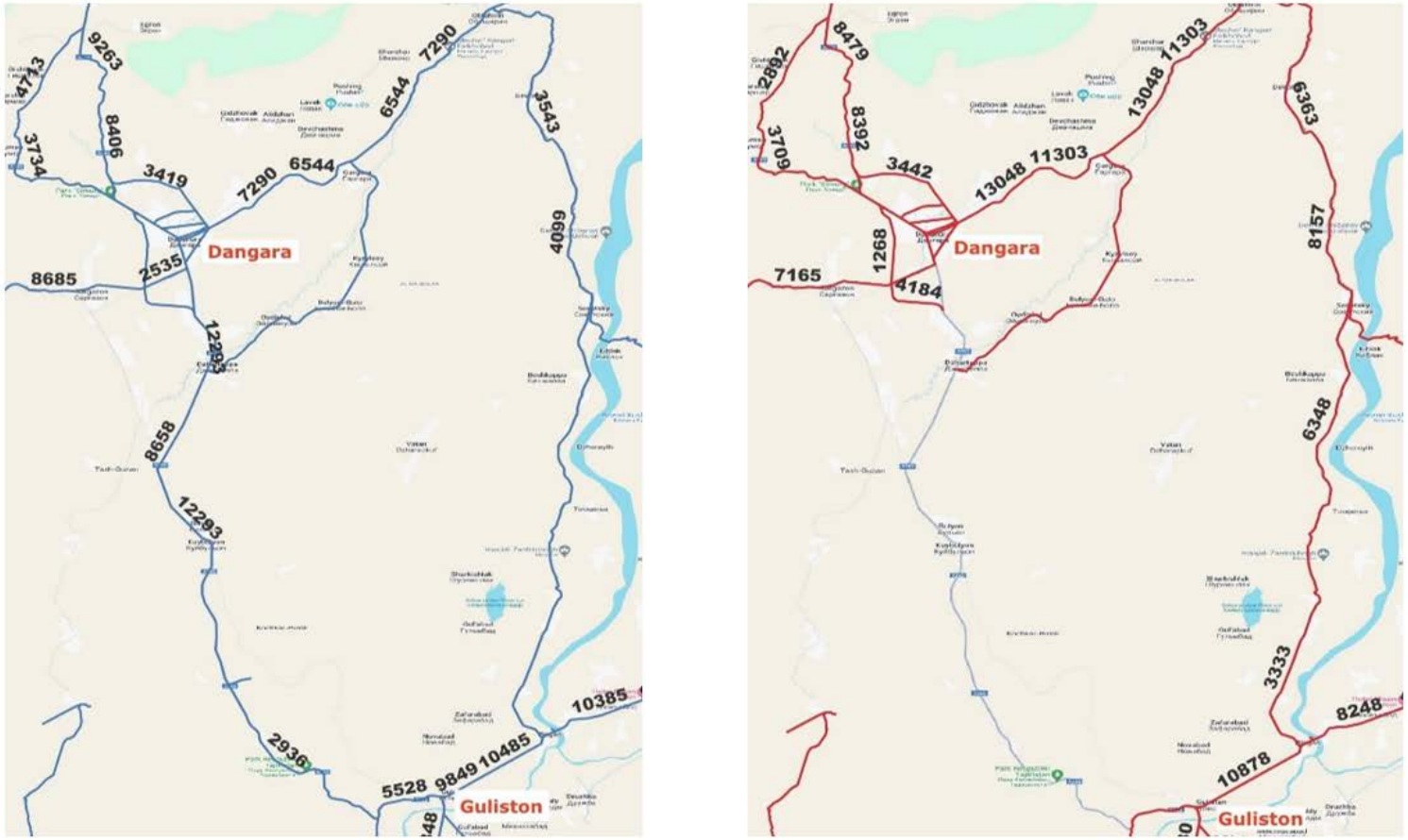
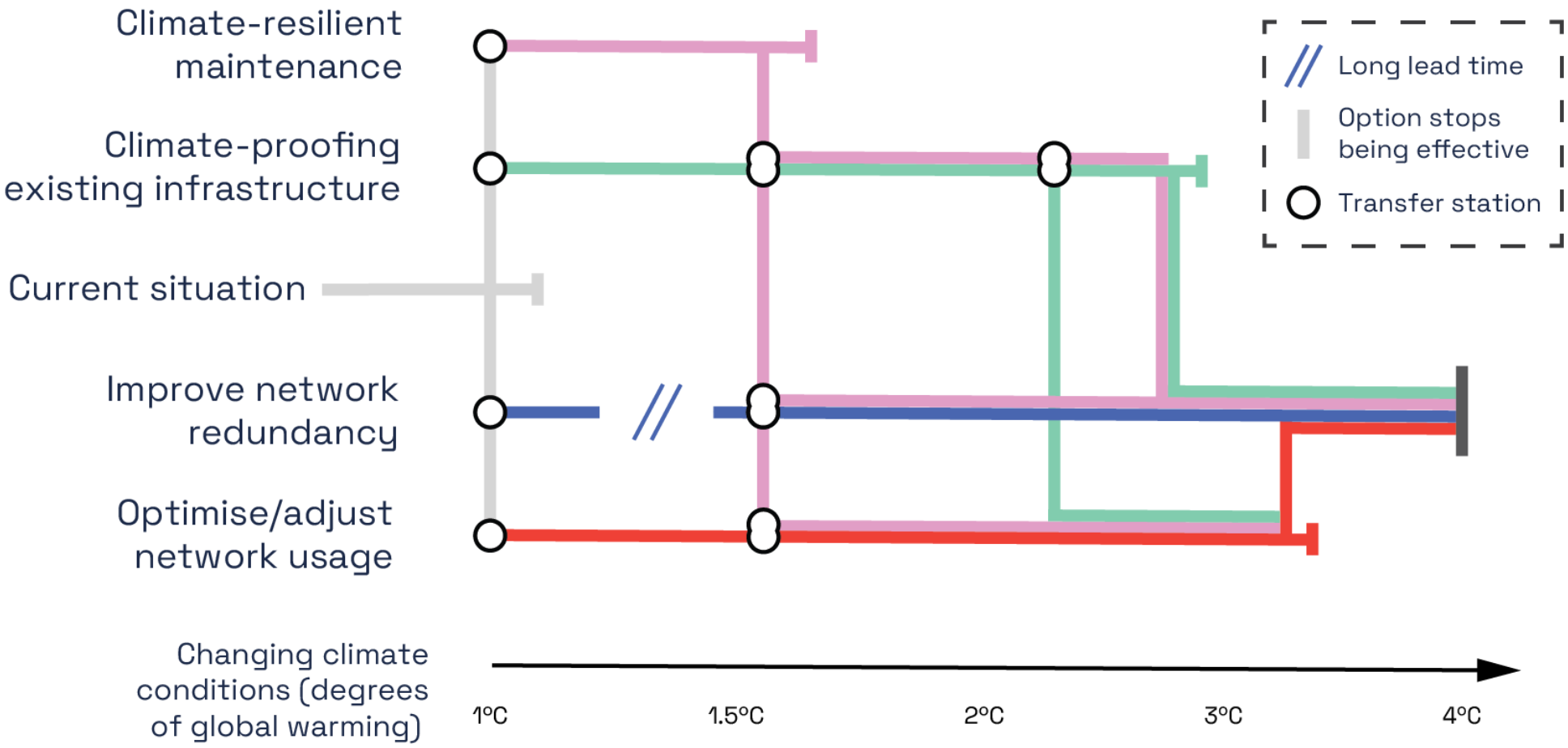


Figure 42 | *Example of local flows (from the national model), before (left) and after (right) the road closure*

Adaptation Pathways



Impact of Adding New Connections

ConnectPNG programme to construct or significantly upgrade 16,000km of roads – what is the impact?

New Road Manuals (PNG)

- Dr Theuns Henning leading Road Design Manual
- Dr Ian Greenwood leading Road Maintenance Manual

- Alignment from high level climate and disaster modelling, through to how roads are designed and maintained.

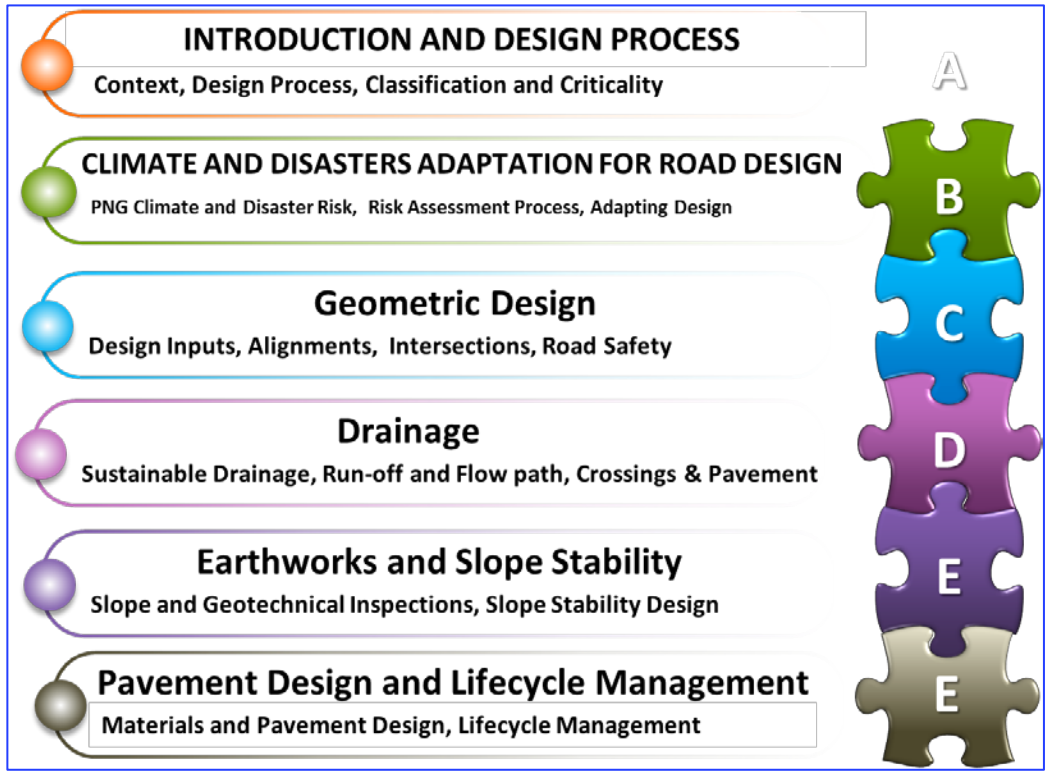
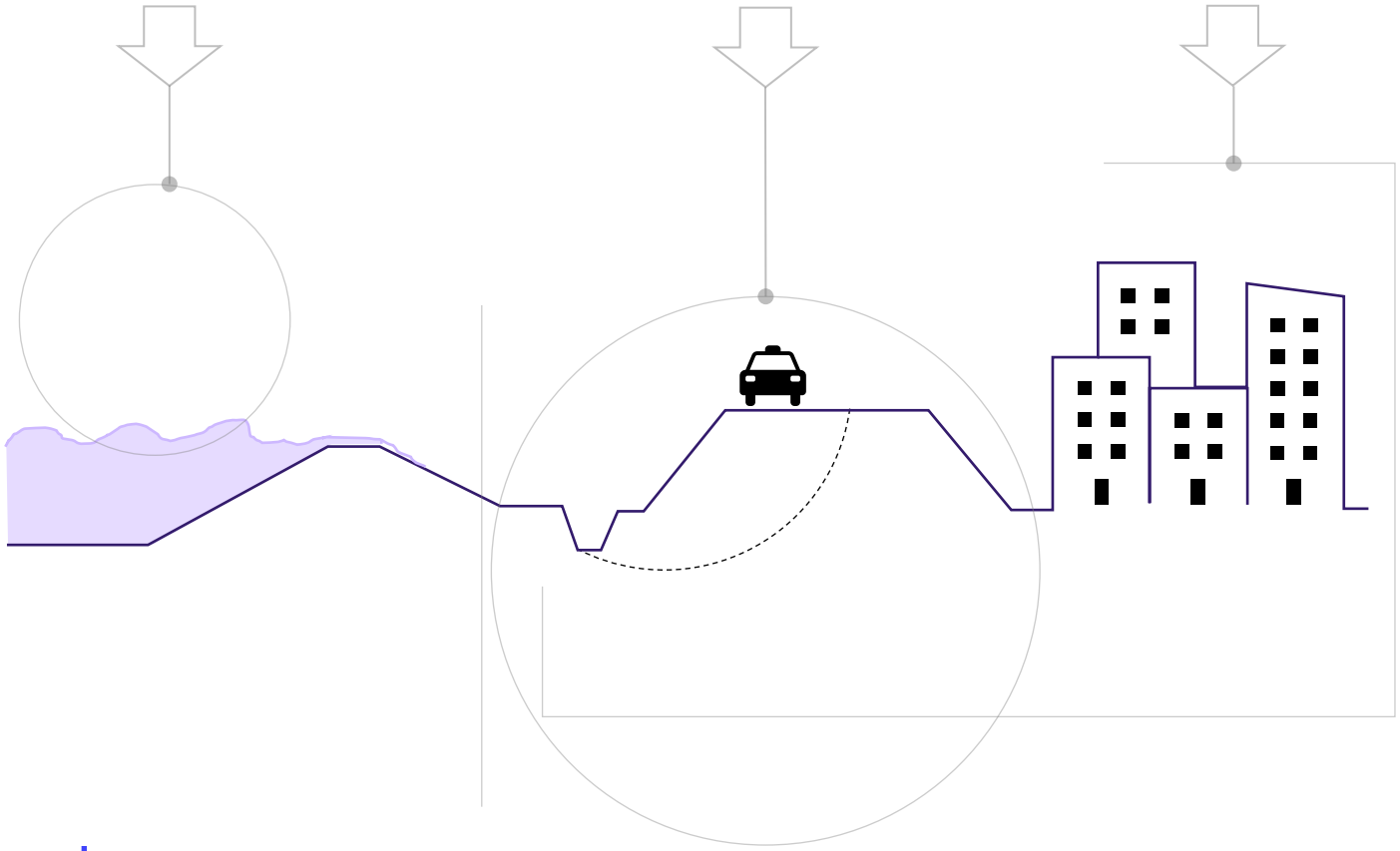


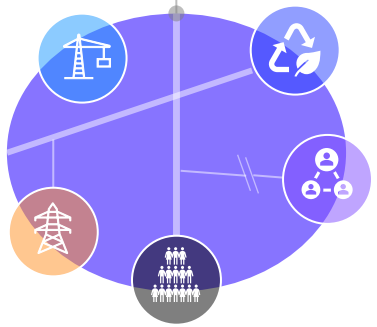
Table 13: Drainage Performance Measures

Criteria	Performance Measure	Flooding Resilience Classification		
		Low	Medium	High
Earth side drains	Number of blockages of more than 10% of cross-sectional area per km of road (sum total of both sides of the road)	10	5	1
	Number of blockages of more than 30% of cross-sectional area per km of road (sum total of both sides of the road)	0	0	0
Concrete lined side drains	Number of blockages of more than 10% of cross-sectional area per km of road (sum total of both sides of the road)	5	2	1
	Number of blockages of more than 30% of cross-sectional area per km	0	0	0

SUMMARY

Adaptation At Many Levels





Adaptation Appraisal

- Asset-level strategies
- System-level strategies
- Network-level strategies

Avoided Losses

Adaptation Costs

Investment decisions

- Large scale climate and natural hazard modelling provides national consistency in the identification of risks, and is very doable.
- Much can be done without setting foot in the country
    - There are large data sets available if you know where to look (and have access).
    - Still the need for ‘ground truthing’ the adaptation pathways.
- Meeting the resilience challenge requires a range of thinking over the full lifecycle of the asset.

Want more detail, then join the ADB Green Roads Webinar Series Thursday 19th March, 7-8pm NZ Time

THANK YOU

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