Switching Gears: Pedalling to Climate Resilient Transport

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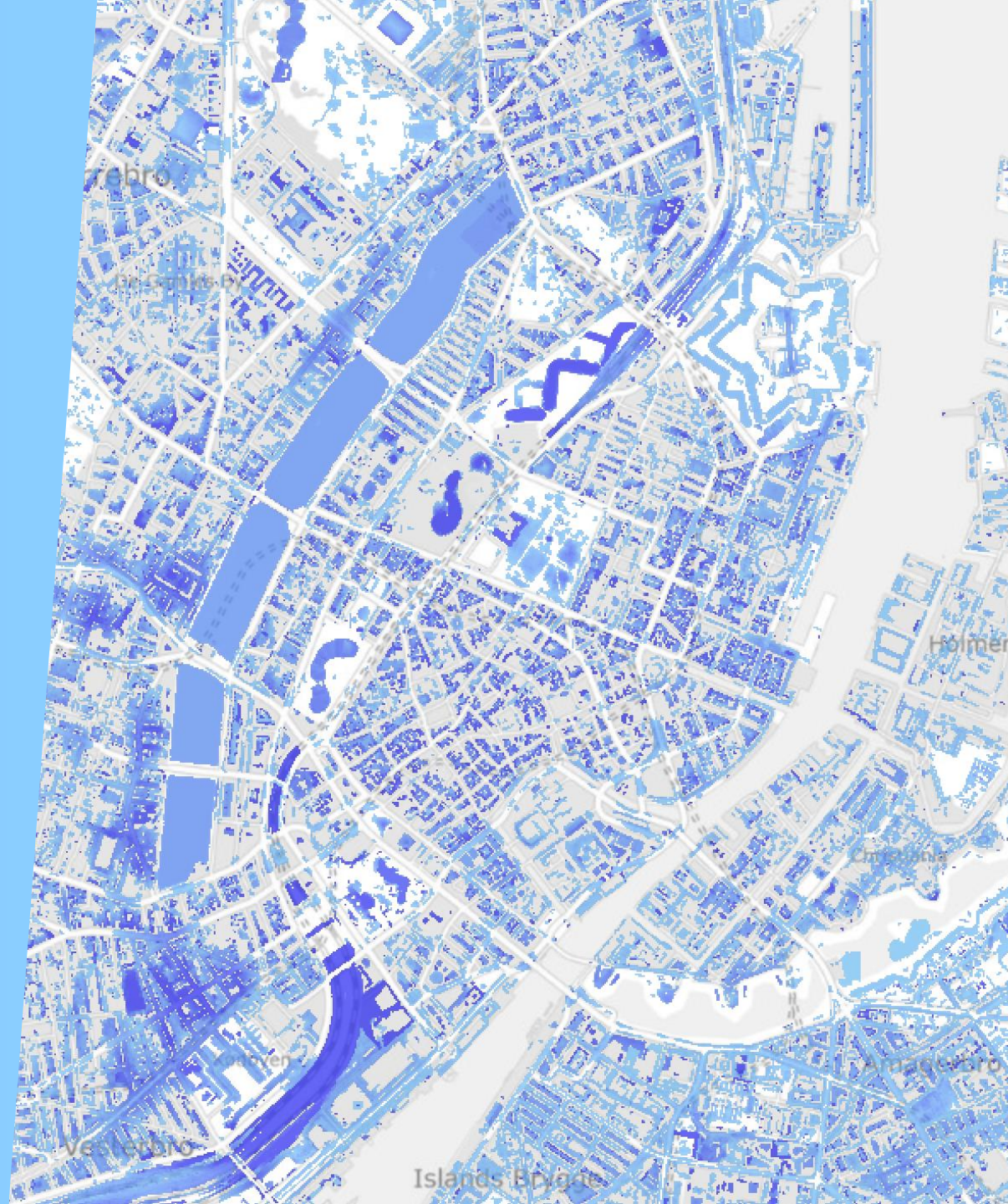
EIT DTN Annual Forum 2025



Story #1	Story #2	Story #3
Cycling Safety	**Long-term climate adaptation**	**???**
the phd	*after the phd*	

Story #1

Objective vs. Subjective Cycling Safety

the phd…

Cycling safety

Objective Safety

Relates to the number of cycling fatalities, injuries, collisions or crashes

What is the link between the built environment, accident contributing factors, and accident outcomes?

Subjective Safety

Relates to the feeling of safety and how individuals subjectively experience accident risk.

What urban factors impact the perception of cycling safety?

CYCLANDS

Worldwide collection of bicycle accidents

30 Datasets

~1.6M accidents

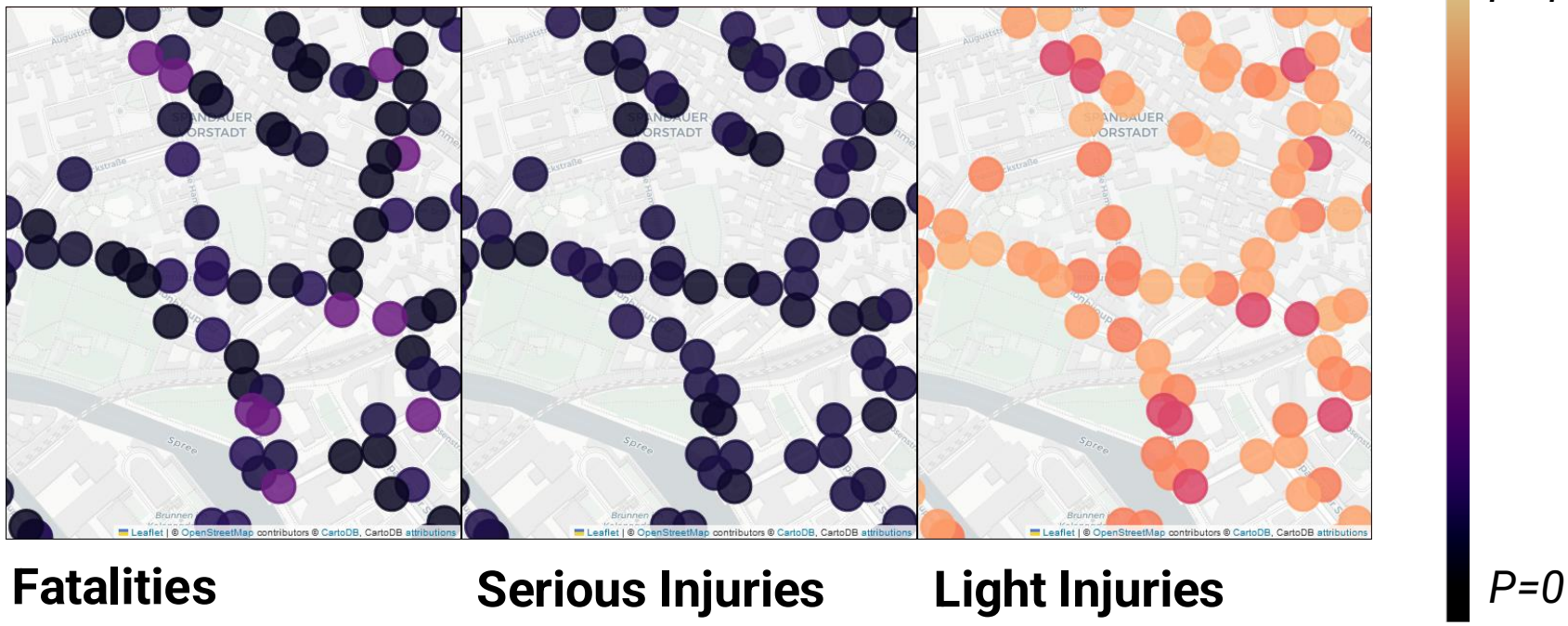
5 Countries
7 Regions
18 Cities

Costa, M., Marques, M., Roque, C., Moura, F. (2022). CYCLANDS: Cycling geo-located accidents, their details and severities. Scientific Data, 9(1), 1-9.

Mapping of accident outcomes

For a given accident type, we can map the probability of an accident outcome depending on where it happens

<u>Accident type:</u> Cycling accidents involving heavy vehicles at dark.



Fatalities **Serious Injuries** **Light Injuries**

Costa, M., Azevedo, C. L., Siebert, F. W., Marques, M., & Moura, F. (2024). Unraveling the relation between cycling accidents and built environment typologies: Capturing spatial heterogeneity through a latent class discrete outcome model. Accident Analysis & Prevention, 200, 107533.

Comparing images

Exploring image comparisons as a new way to acquire data on urban perceptions

Costa, M., Marques, M., Azevedo, C. L., Siebert, F. W., & Moura, F. (2025). Which cycling environment appears safer? Learning cycling safety perceptions from pairwise image comparisons. IEEE Transactions on Intelligent Transportation Systems, 26(2)

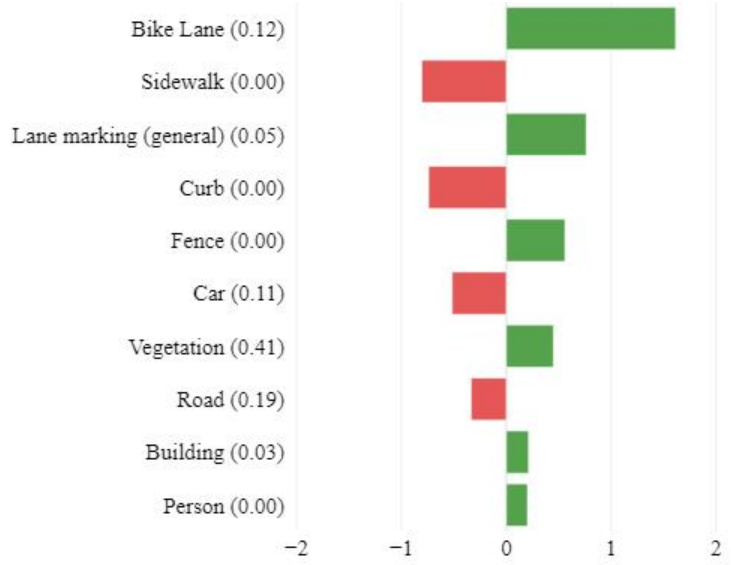
Mapping perceived scores

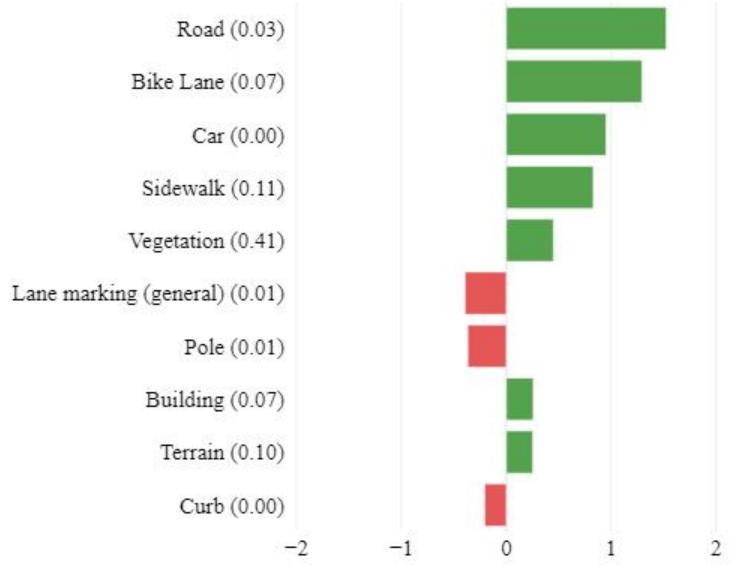
Mapping perception of cycling safety at a city-wide scale

Costa, M., Marques, M., Azevedo, C. L., Siebert, F. W., & Moura, F. (2025). Which cycling environment appears safer? Learning cycling safety perceptions from pairwise image comparisons. IEEE Transactions on Intelligent Transportation Systems, 26(2)

Inspect specific environments

You can analyze how different urban elements contribute to an increase/decrease of perception of safety





environment types effects

Objective Safety (severity-based)

Cycle Haven

<

Green Transit

<

Industrial Artery

<

Crossroads Transit

<

Cozy Pedal Haven

<

Drive-centric Commercial

Subjective Safety (pairwise comparison-based)

Cozy Pedal Haven

<

Drive-centric Commercial

<

Crossroads Transit

<

Industrial Artery

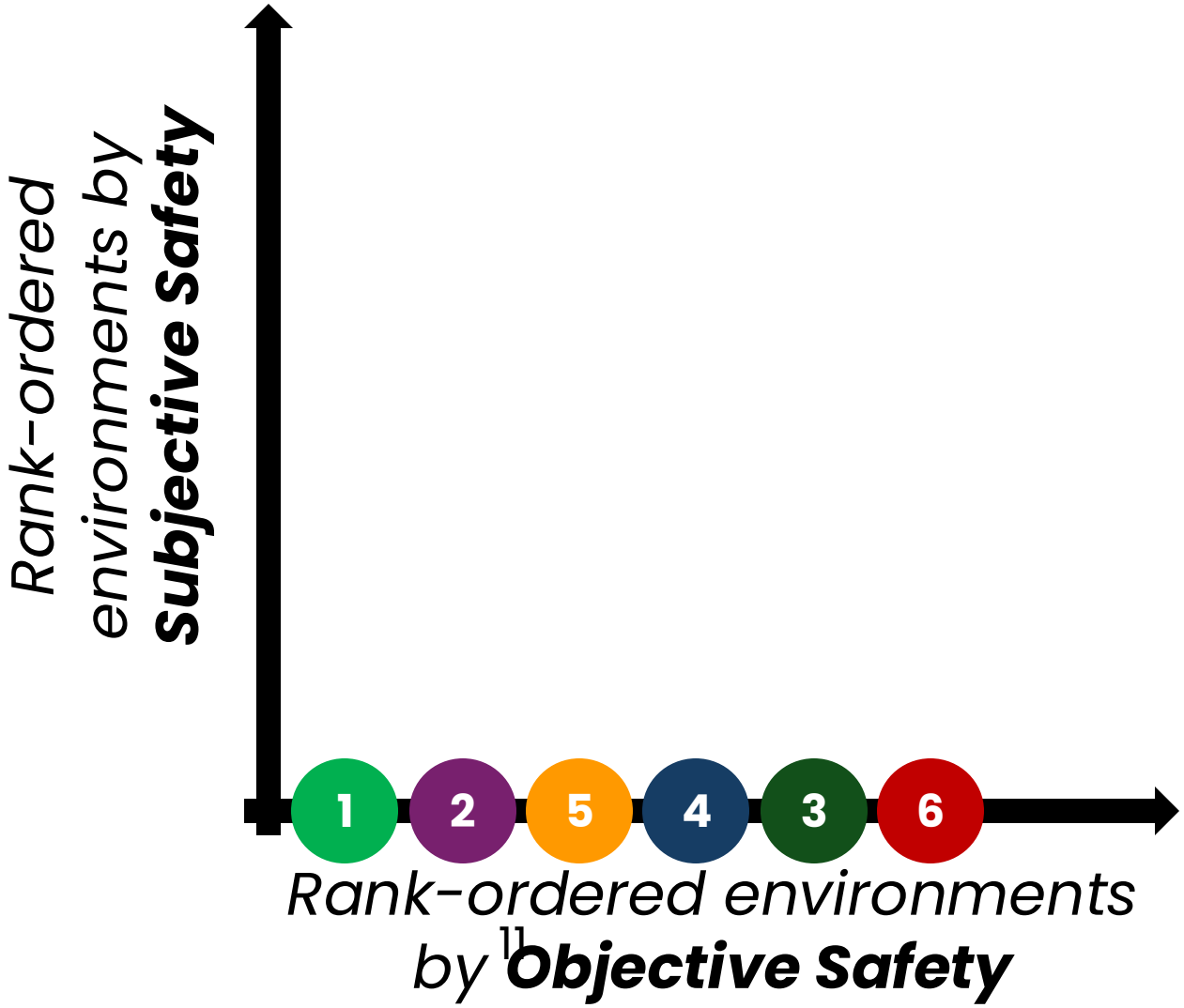
<

Cycle Haven

<

Green Transit

conceptual safety relation



1. Class 1 - Cycle haven
2. Class 2 - Green transit hub
3. Class 3 - Cozy Pedal Haven
4. Class 4 - Crossroads transit hub
5. Class 5 - Industrial Artery Zone
6. Class 6 - Drive-centric Commercial Zone

Story #2

AI for Climate-Resilient Transport: Towards Better Quality of Life Under Climate Change

…after the phd

Climate change is impacting how we live

Climate Change	→ High impact weather events are expected to increase → Extreme rainfall is to become more extreme and more frequent

Climate change is impacting how we live

Climate Change	→ High impact weather events are expected to increase → Extreme rainfall is to become more extreme and more frequent
Impacts	→ Transport Infrastructure → Mobility → Wellbeing

Climate change is impacting how we live

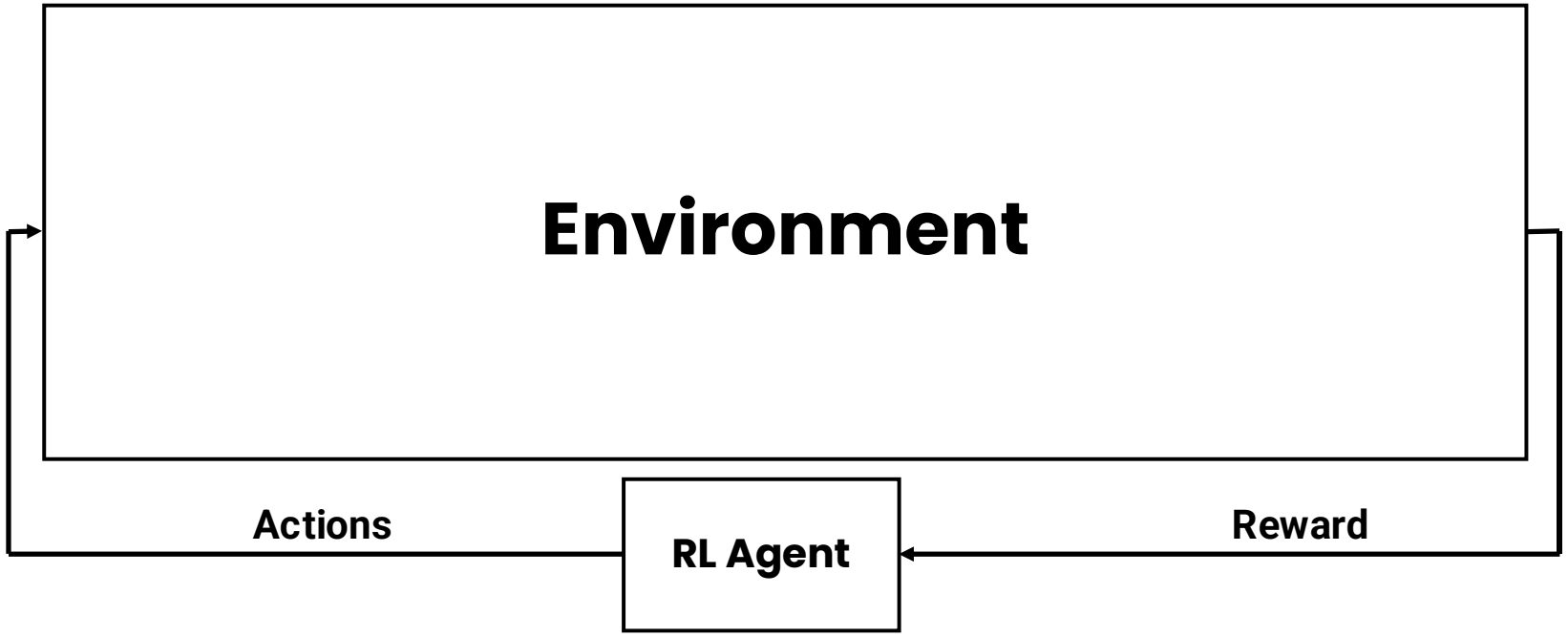
Climate Change	→ High impact weather events are expected to increase → Extreme rainfall is to become more extreme and more frequent
Impacts	→ Transport Infrastructure → Mobility → Wellbeing
Wellbeing	→ Has been associated with, e.g., life expectancy & economic productivity → Motility plays a key role in one's wellbeing

But how can we model everything?

AI, of course…

that is the solution to everything now!

Reinforcement Learning



Environment

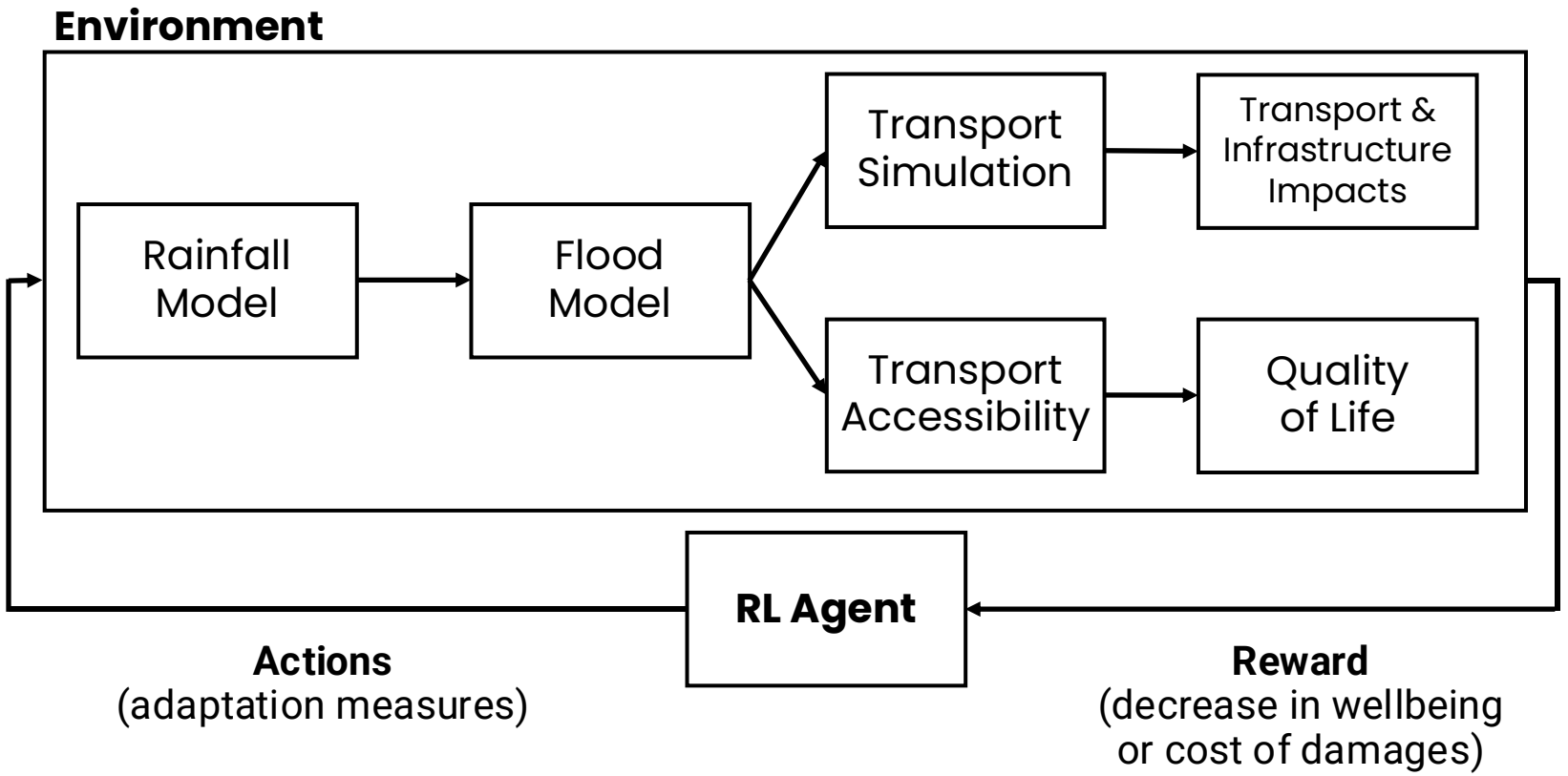
Represents our “world”.

We define how it behaves, how it can be interacted with, and what we can observe

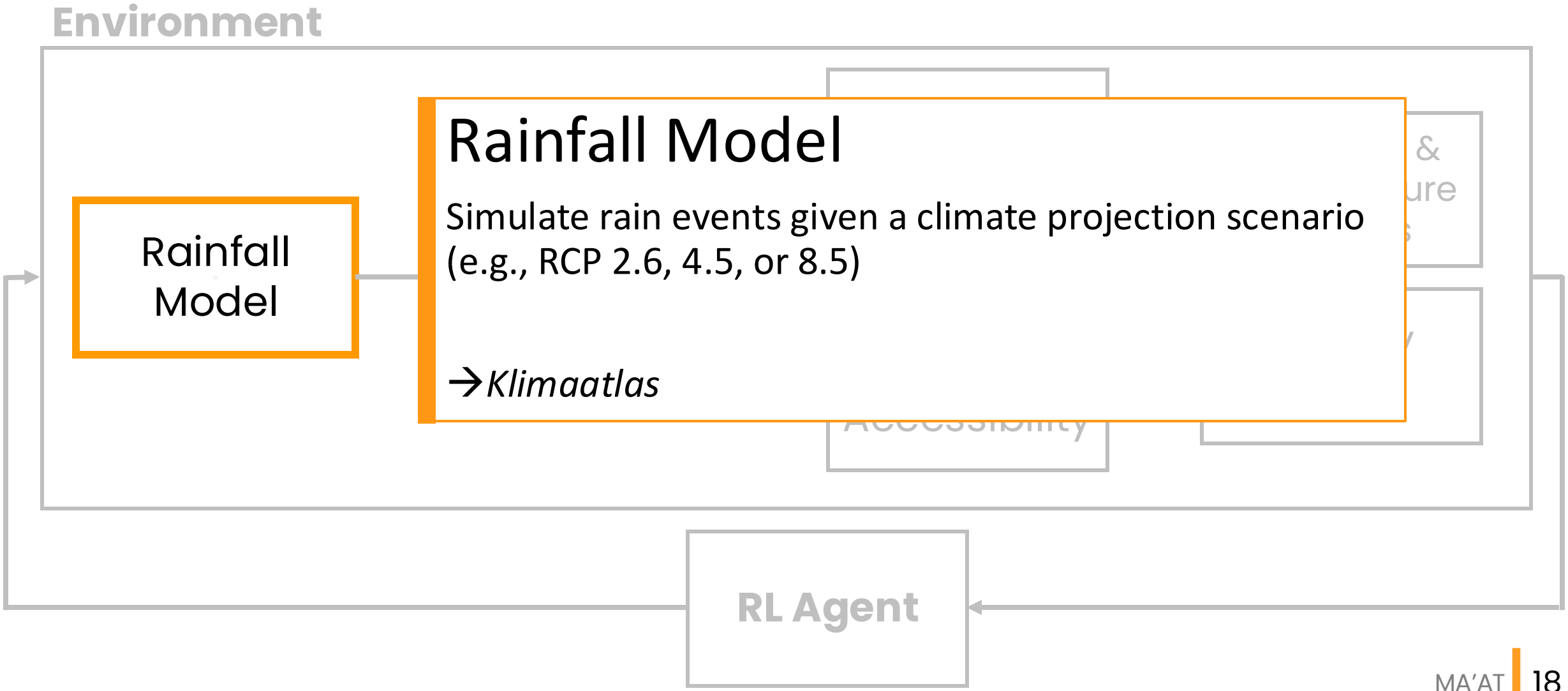
Agent

Iteratively interact with the environment to learn what are the best actions to take at each time step

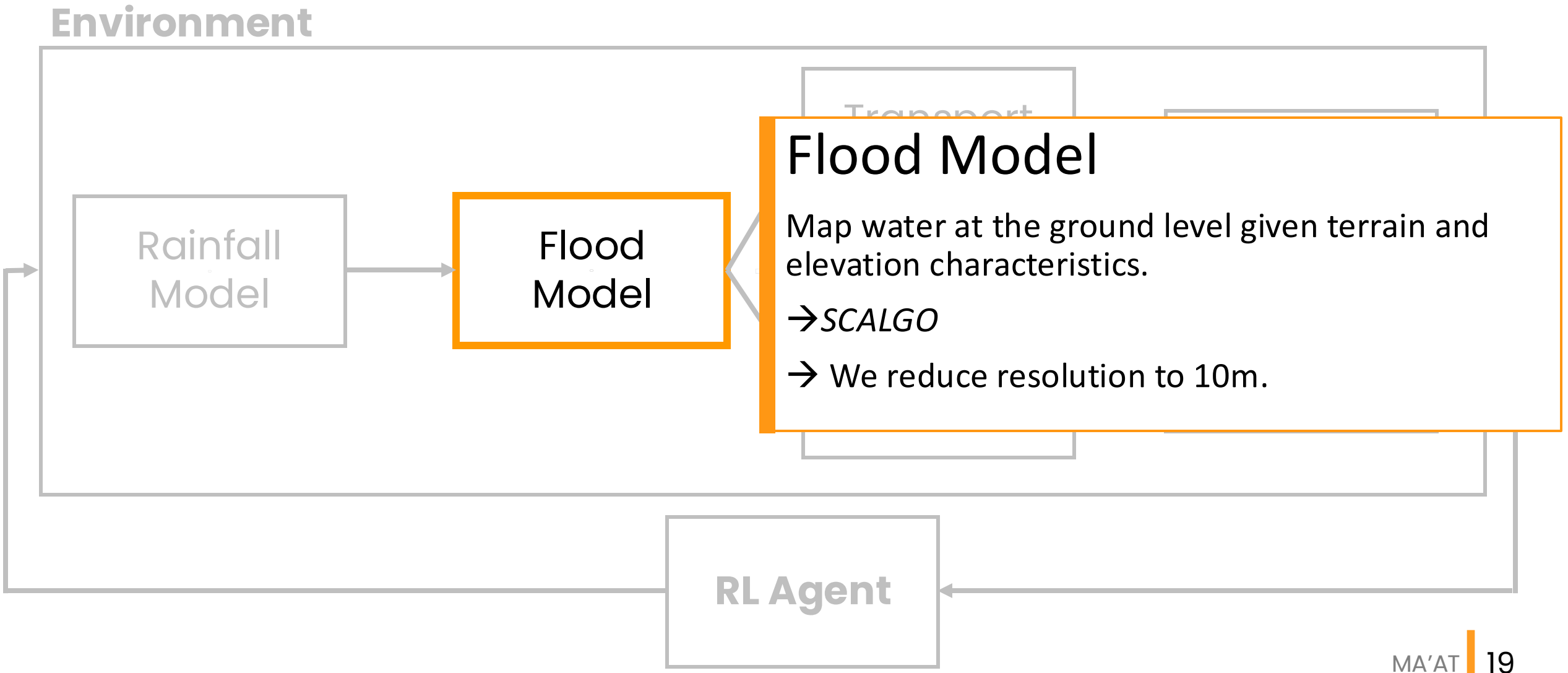
And what is the “world”?



Framework


Environment
Rainfall Model
Rainfall Model
Simulate rain events given a climate projection scenario (e.g., RCP 2.6, 4.5, or 8.5)
→Klimaatlas
RL Agent

Framework



Flood Model

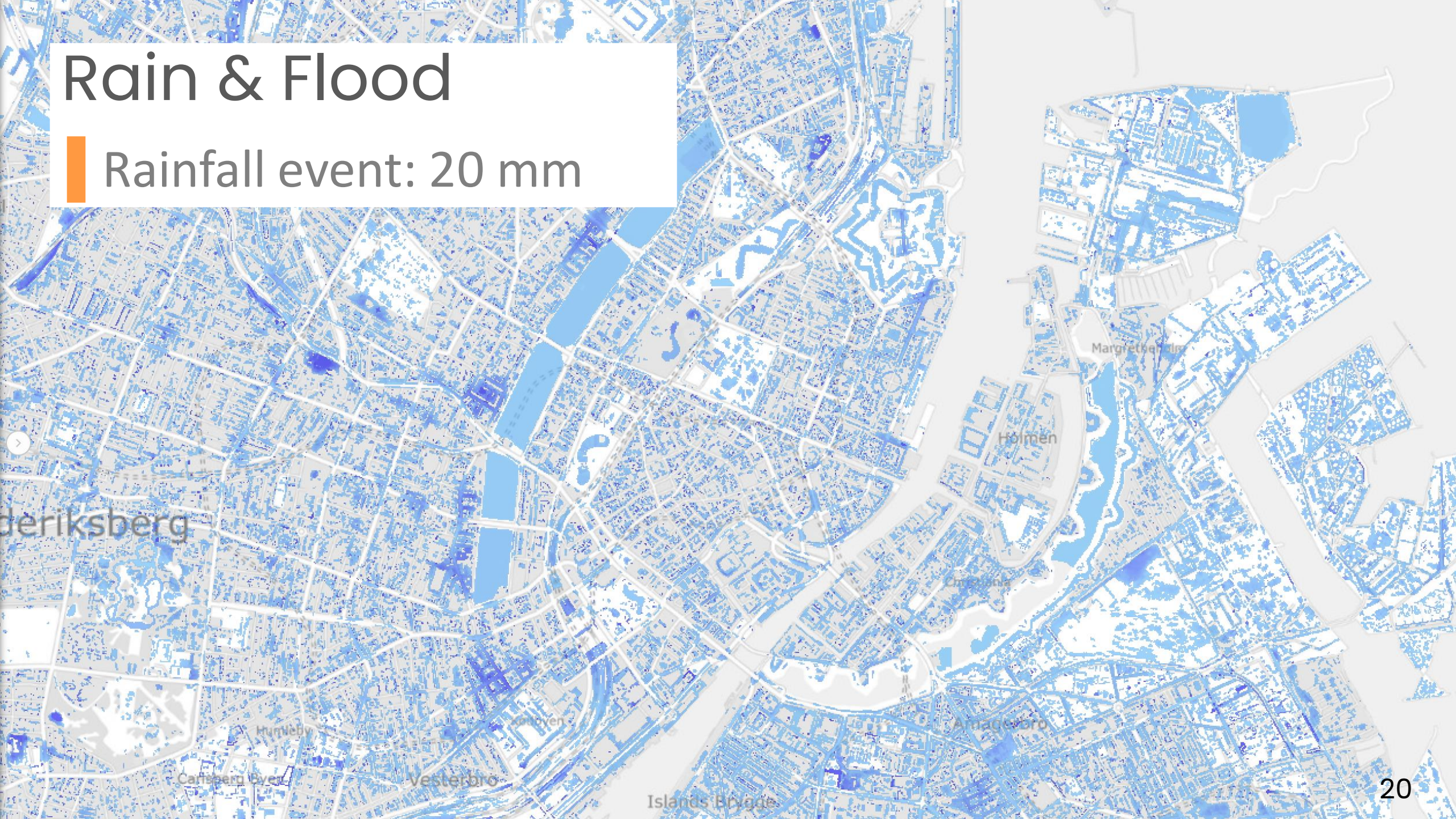
Map water at the ground level given terrain and elevation characteristics.

→*SCALGO*

→ We reduce resolution to 10m.

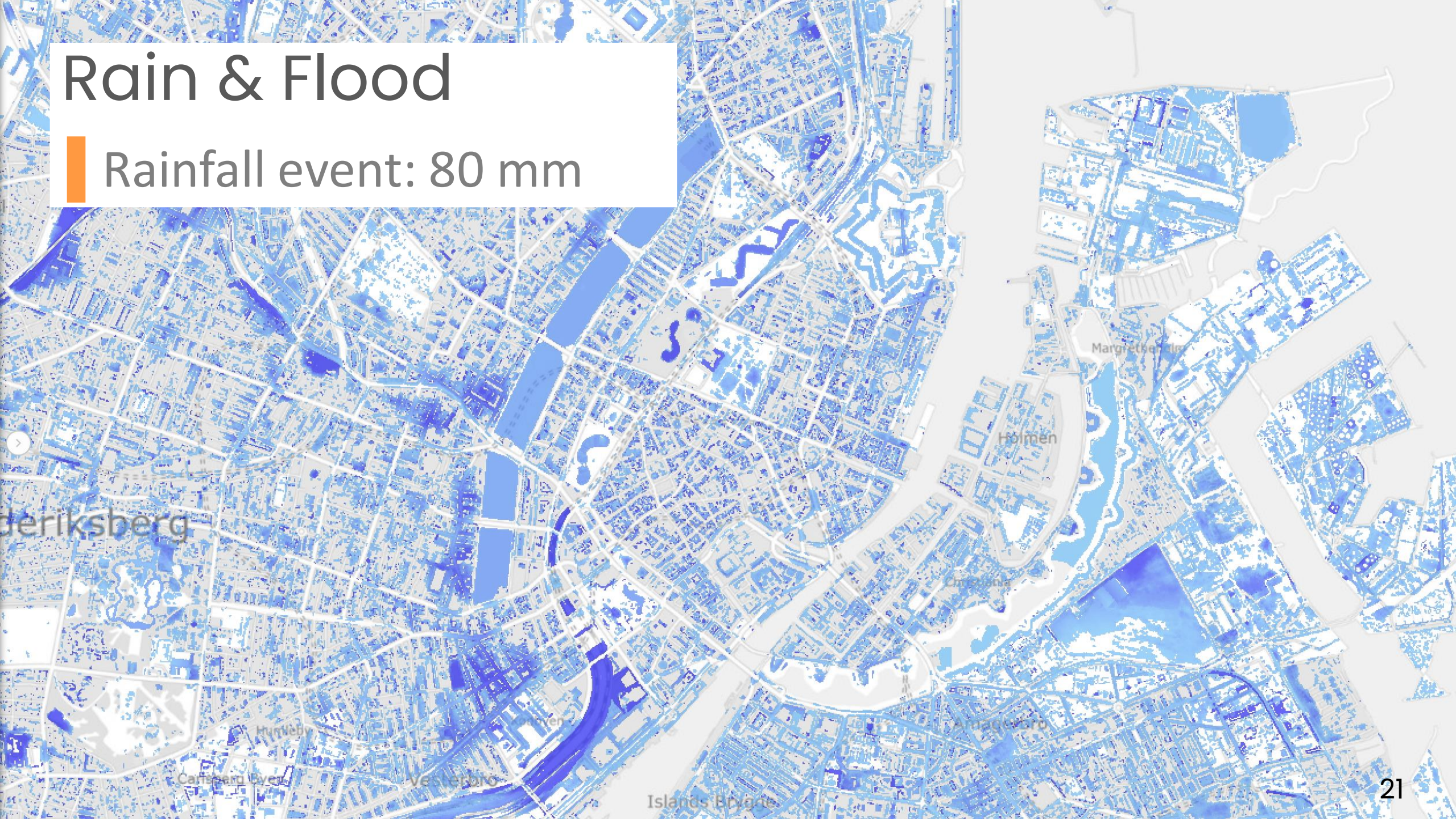
Rain & Flood

Rainfall event: 20 mm



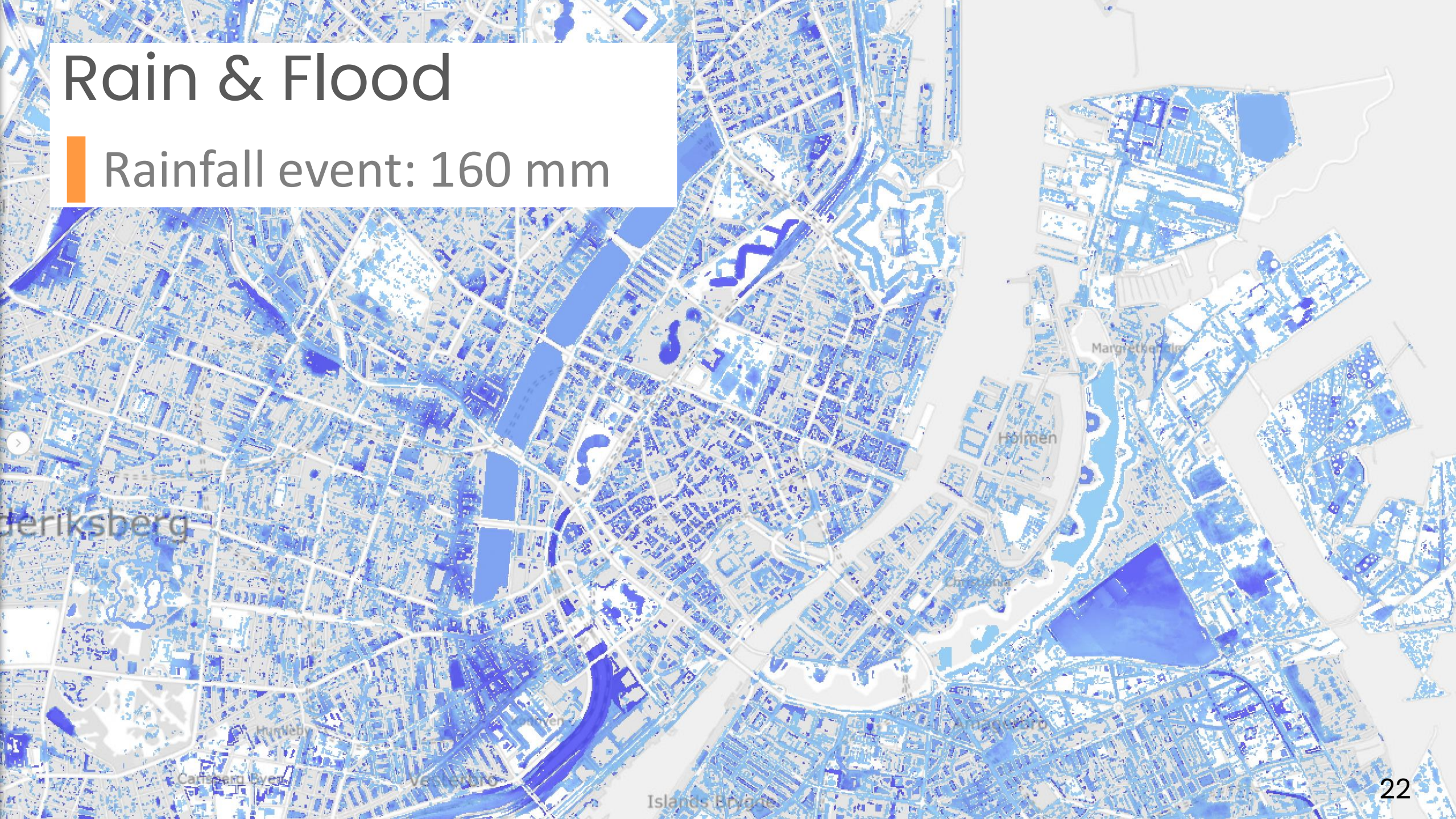
Rain & Flood

- Rainfall event: 80 mm

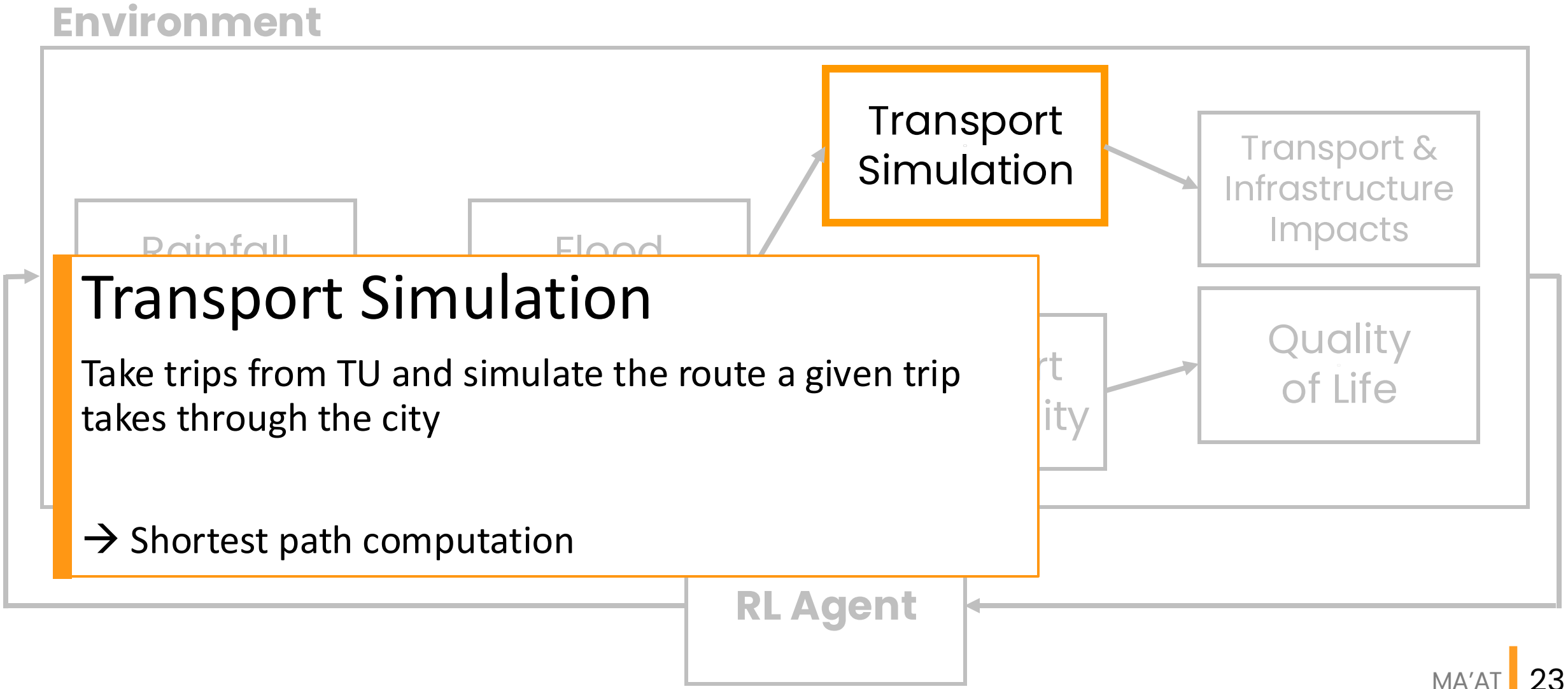


Rain & Flood

- Rainfall event: 160 mm



Framework

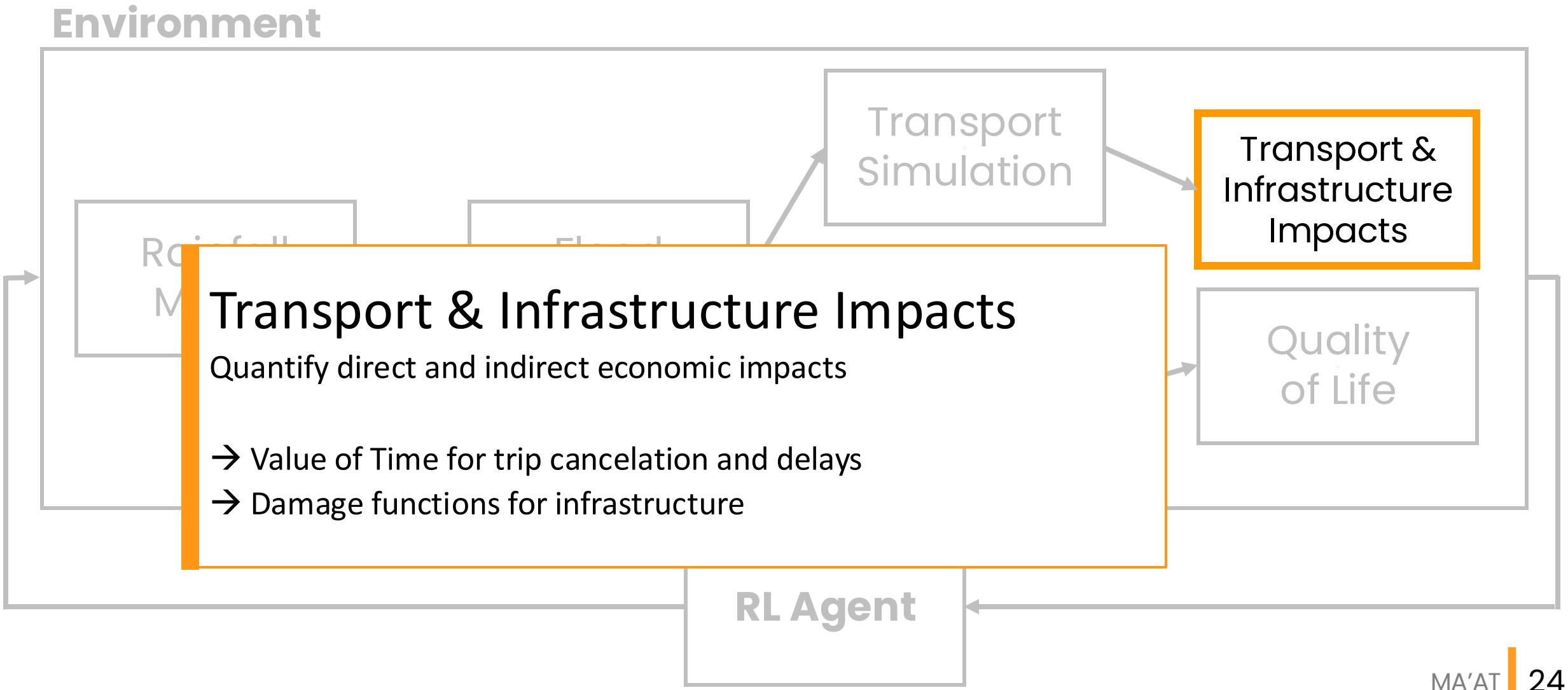


Transport Simulation

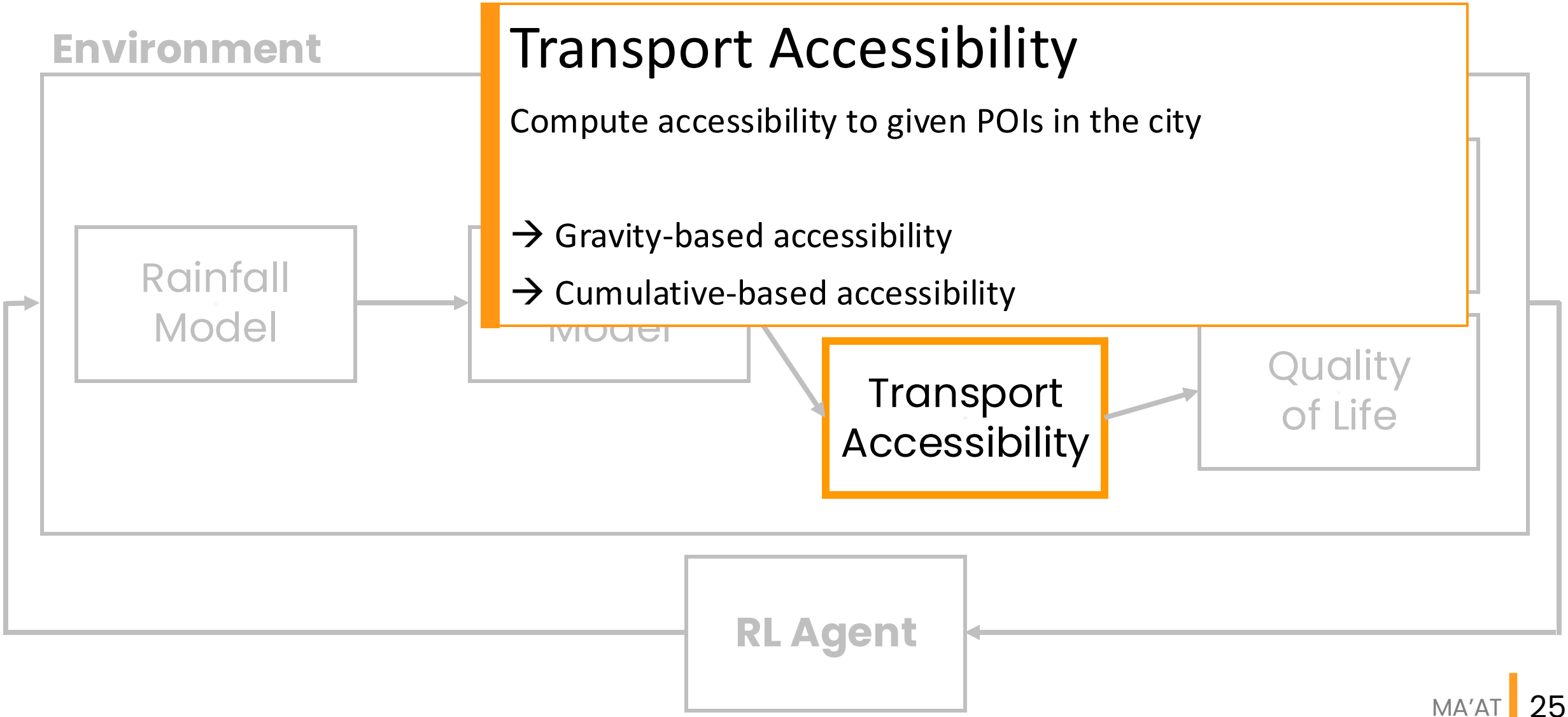
Take trips from TU and simulate the route a given trip takes through the city

→ Shortest path computation

Framework


Environment
Transport Simulation
Transport & Infrastructure Impacts
Quality of Life
RL Agent
Transport & Infrastructure Impacts
Quantify direct and indirect economic impacts
→ Value of Time for trip cancelation and delays
→ Damage functions for infrastructure

Framework



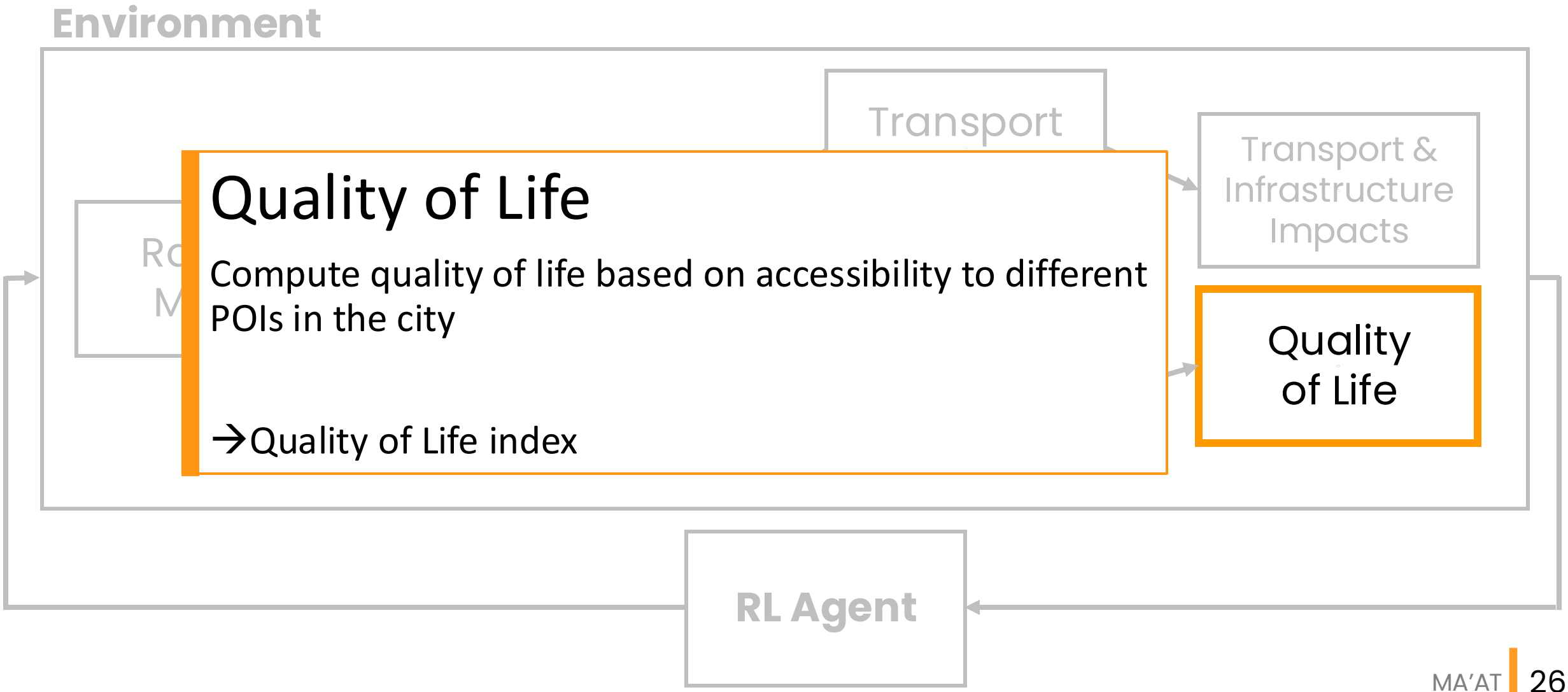
Transport Accessibility

Compute accessibility to given POIs in the city

→ Gravity-based accessibility

→ Cumulative-based accessibility

Framework


Environment
Transport
Transport & Infrastructure Impacts
Quality of Life
Compute quality of life based on accessibility to different POIs in the city
→Quality of Life index
Quality of Life
RL Agent

Actions: Adaptation Measures

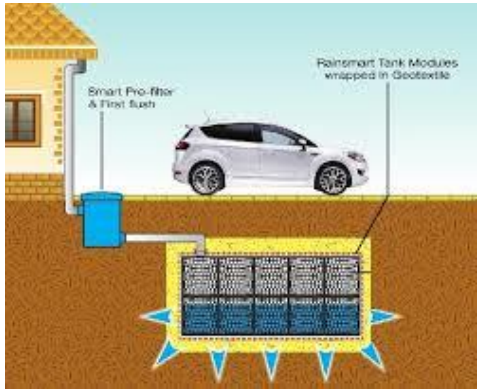
Bioretention Planters

Screenshot from *National Association of City Transportation Officials. (2017). Urban Street Stormwater Guide. Island Press.*

SE Tacoma Ave, **PORTLAND, OR**

Storage Tanks/Soakways

Screenshot from https://www.kleinfelder.com/project/pl6-stormwater-storage-tank-tunnel/



Screenshot from https://www.drainagepipe.co.uk/soakaways-and-membranes/building-your-soakaway/

Permeable Pavements

Figure 3-4
Pervious concrete adjacent to traditional concrete during a rainfall, Ames, IA
Source: John Kevern

Source: CH2M Hill

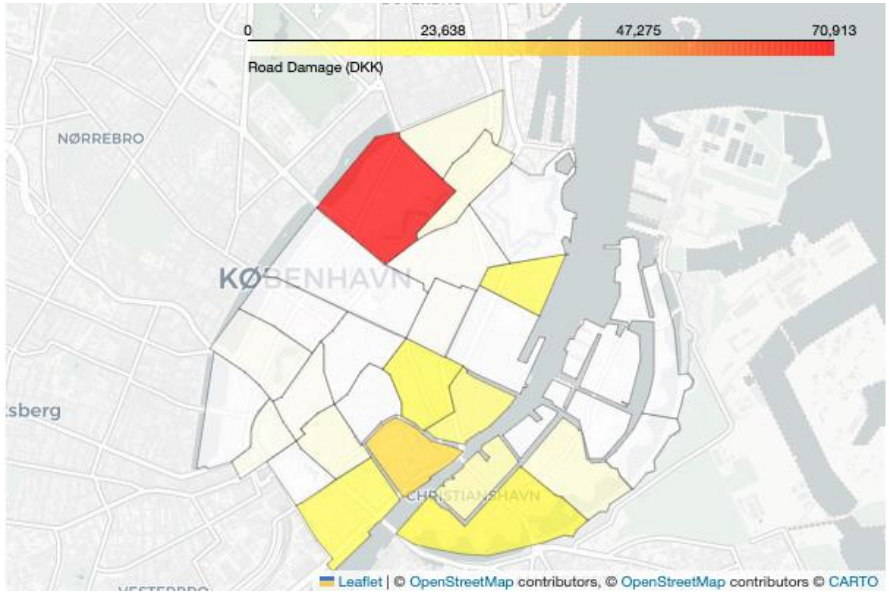
Screenshot from *Permeable Pavements Task Committee. (2015). Permeable pavements. American Society of Civil Engineers*

Possible future actions:

- Early warning systems
- Work from home
- Relocation people/jobs

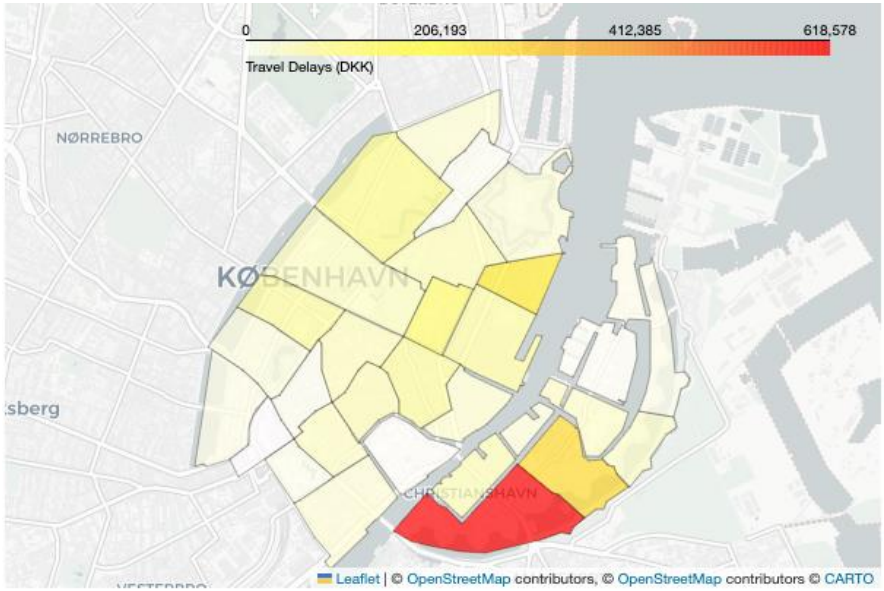
Economic impacts

for a 100mm rainfall event



damage to infrastructure [DKK]

trips' delays [DKK]

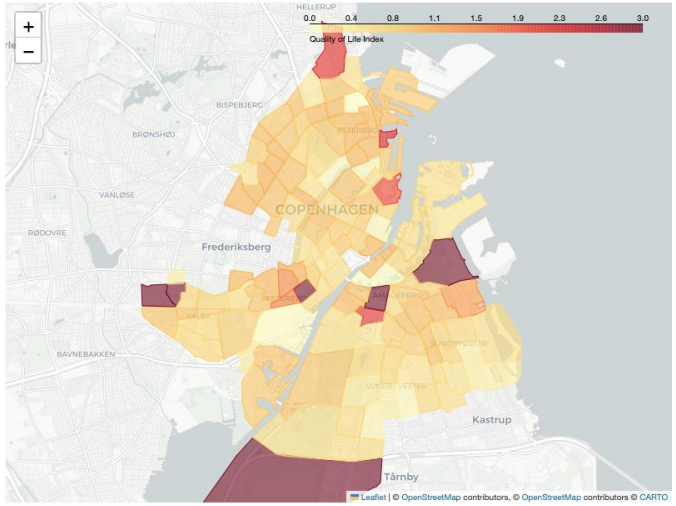


Costa et al. (2024). Climate Adaptation with Reinforcement Learning: Experiments with Flooding and Transportation in Copenhagen. CCAI @ NeurIPS 2024.

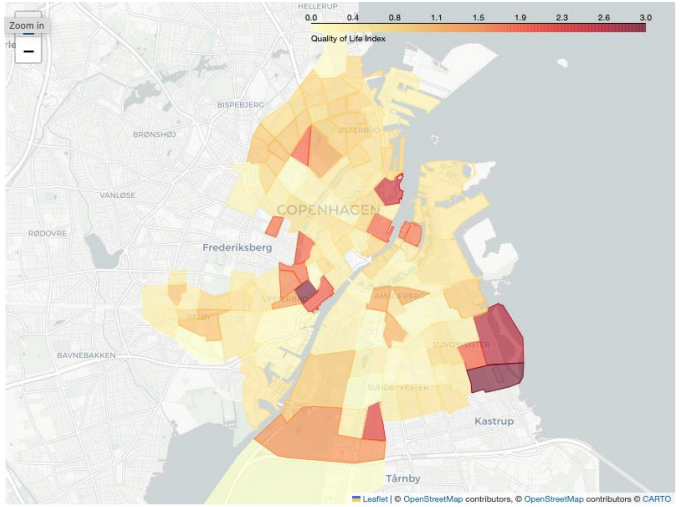
Quality of Life loss

for a 100mm rainfall event

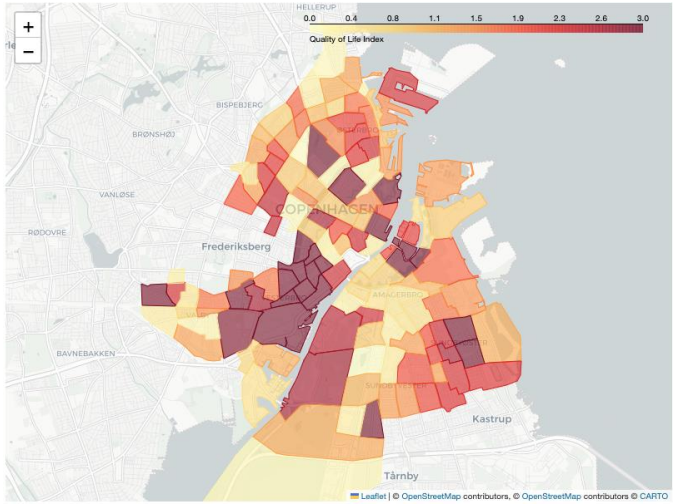
Car



Walking



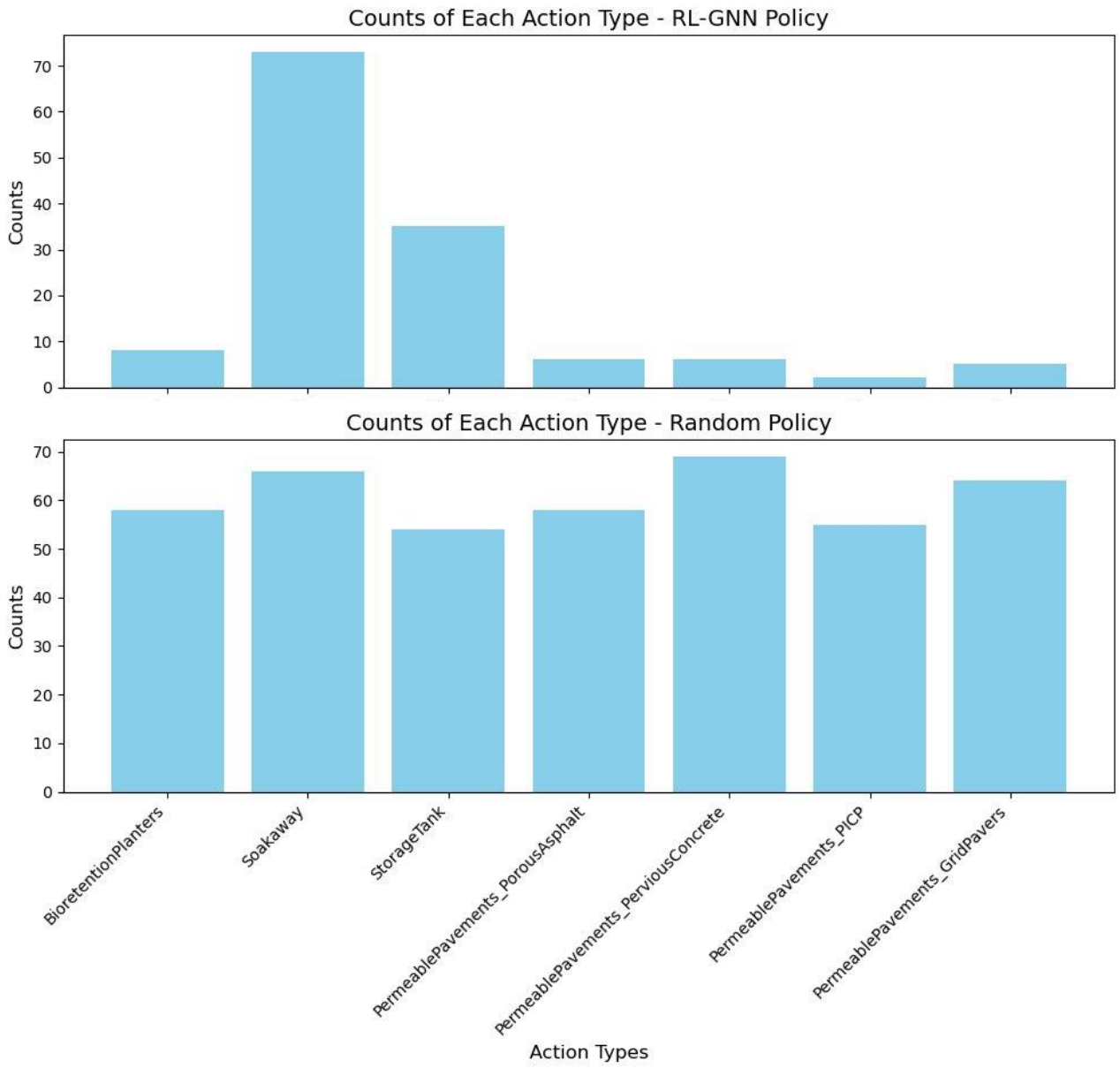
Bicycle



preliminary results, ongoing work

What do we learn?

when and where to take an action in the city



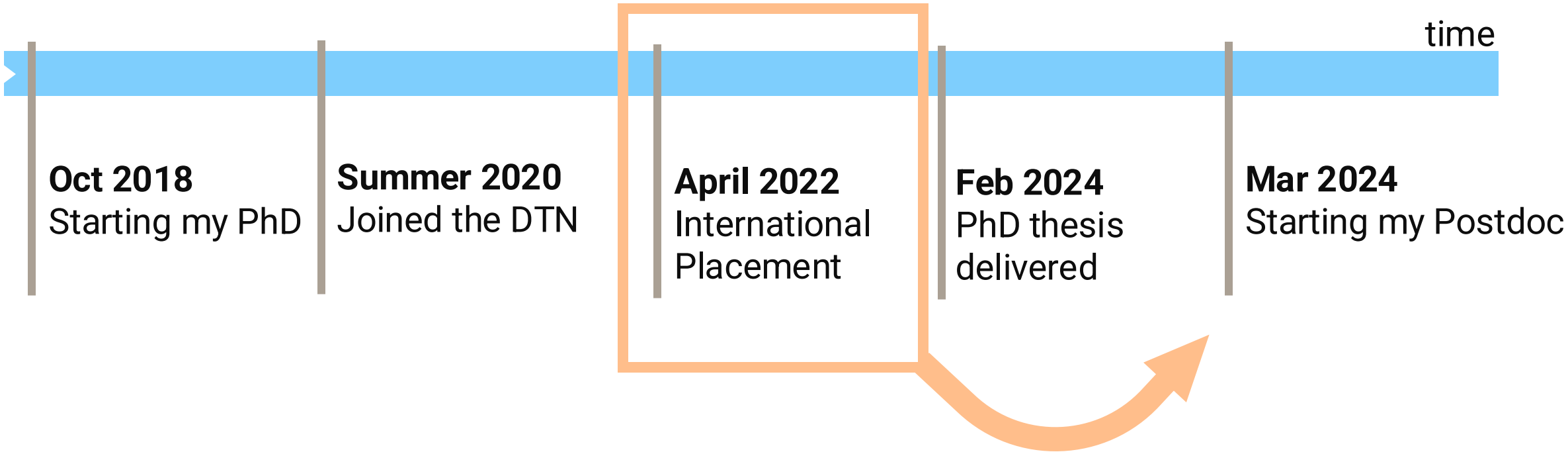
RL (learnt actions)

Random control

Story #3

???

Academic path



Story #3

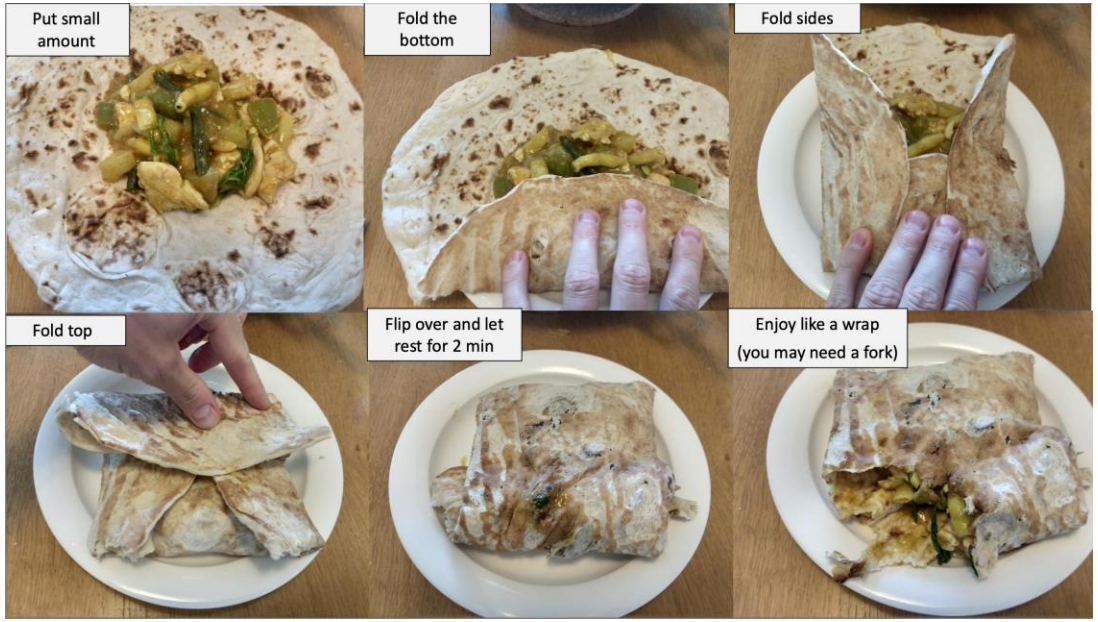
The EIT Urban Mobility Doctoral Training Network

how the DTN helped me

International Placement

Machine Learning for Smart Mobility (MLSM) group at the Technical University of Denmark

Learning new skills are important



But it’s the connections along the way where the true value is

and as a great philosopher once said

“ Create memories. Create friendships. ”

Benjamin Büttner, 2025

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