NINA URBAG UAB Universitat Autònoma de Barcelona

Green roofs in Oslo by 2030

Co-creating a common understanding of impacts and relevance for the city

Join us to discuss green roofs' impacts within and beyond the city of Oslo and explore their significance for the city's urban planning

ONLINE WORKSHOP

When: Monday, January 29th / 13:00 - 16:00
Where: Zoom Webinar

Green roofs in Oslo by 2030

Co-creating a common understanding of impacts and relevance for the city

Agenda

13:00	**Welcome and Introduction**
13:10	Research project background, objectives and relevance of the Oslo case study (Gara Villalba / ICTA-UAB)
13:15	Crafting Policies for Green Roofs: Oslo's green roofs strategy and Blue-green factor (Tore Mauseth / Oslo Kommune)
13:30	Integrated assessment of green roofs in the Oslo Municipality: impacts on cross-scale vulnerabilities (David Camacho / ICTA-UAB)
13:50	Q&A
14:10	Workshop 1: Discussion and weighting of the impacts of green roofs within and beyond Oslo's boundaries
15:10	Break
15:20	Workshop 2: Development of strategies for integrating the cross-scale impacts of green roofs into policy and planning
16:00	**Closure**

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Urban green infrastructures are key stones in building resilient cities

Green roofs in Oslo by 2030: Co-creating a common understanding of impacts and relevance for the city

Online workshop
January 29th, 2024

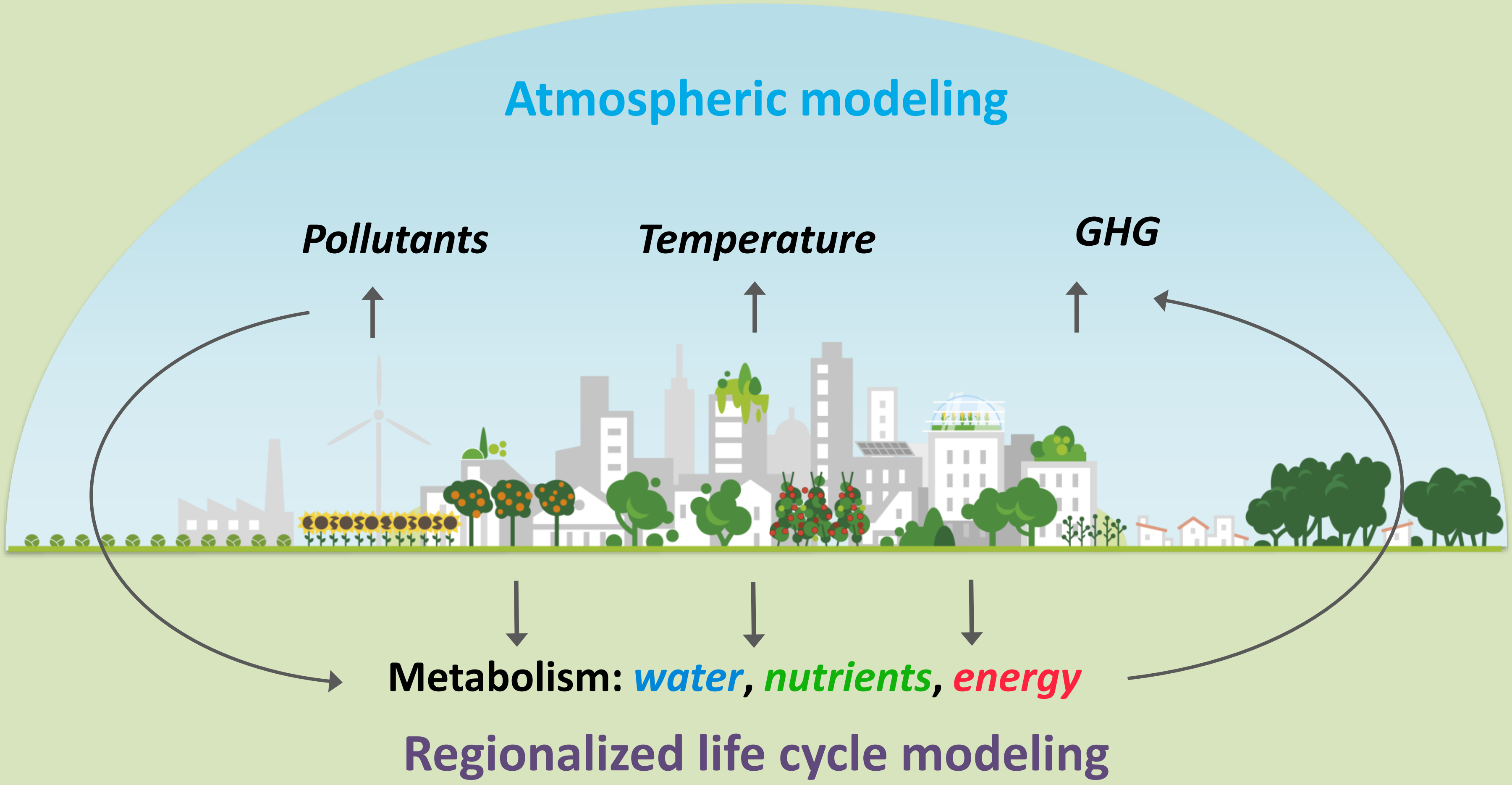
Gara Villalba
Institute of Environmental Science and Technology (ICTA)
Dept of Chemical, Biological, and Env Engineering
Autonomous University of Barcelona (UAB), Spain.

URBAG

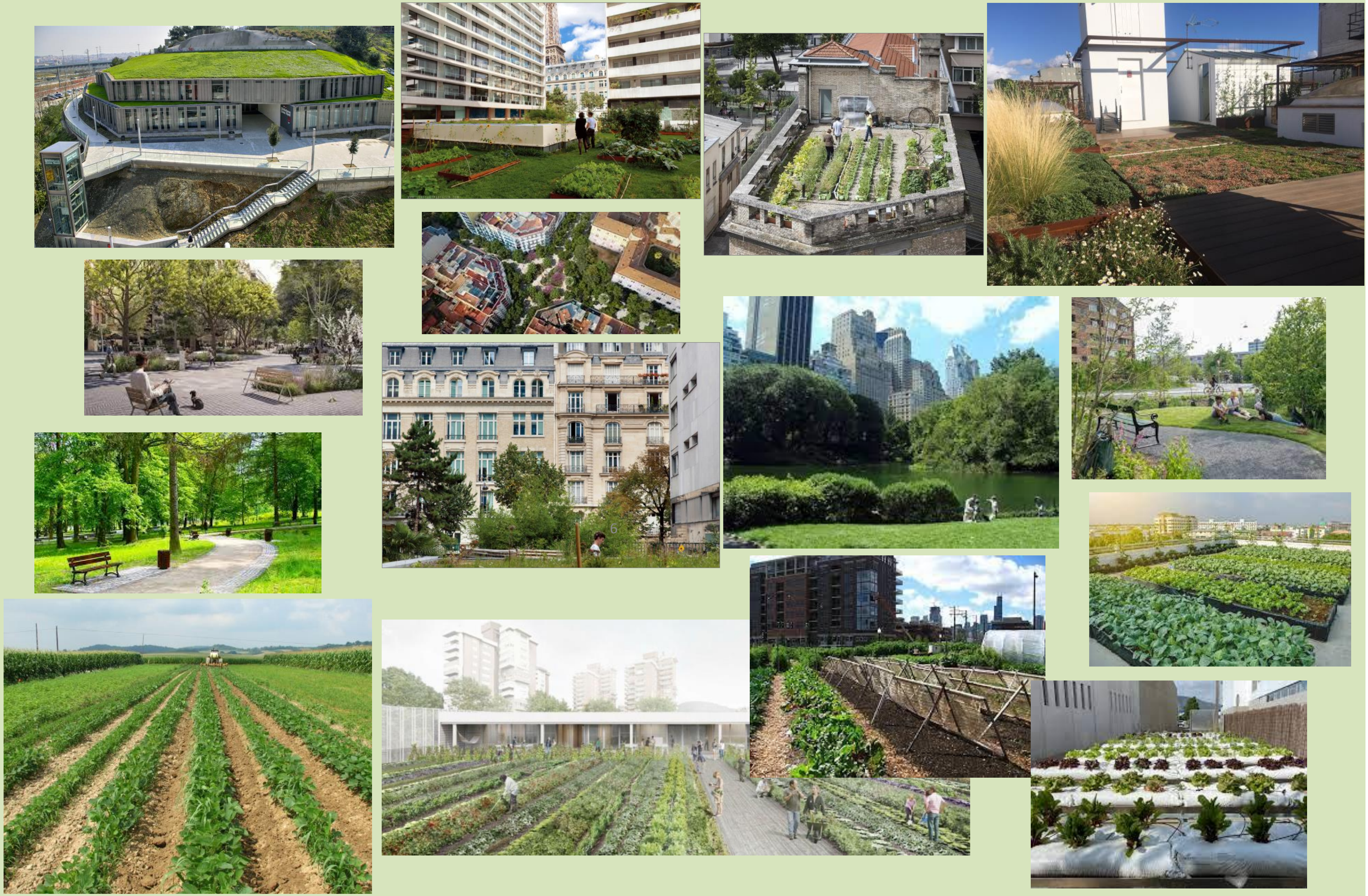
Horizon 2020 European Research Council, 2019-2025

https://urbag.eu

General Vision of URBAG



Green infrastructure: ***a network of (semi-)natural areas which are protected and enhanced to deliver ecosystem services, while also benefiting biodiversity and society more widely.***

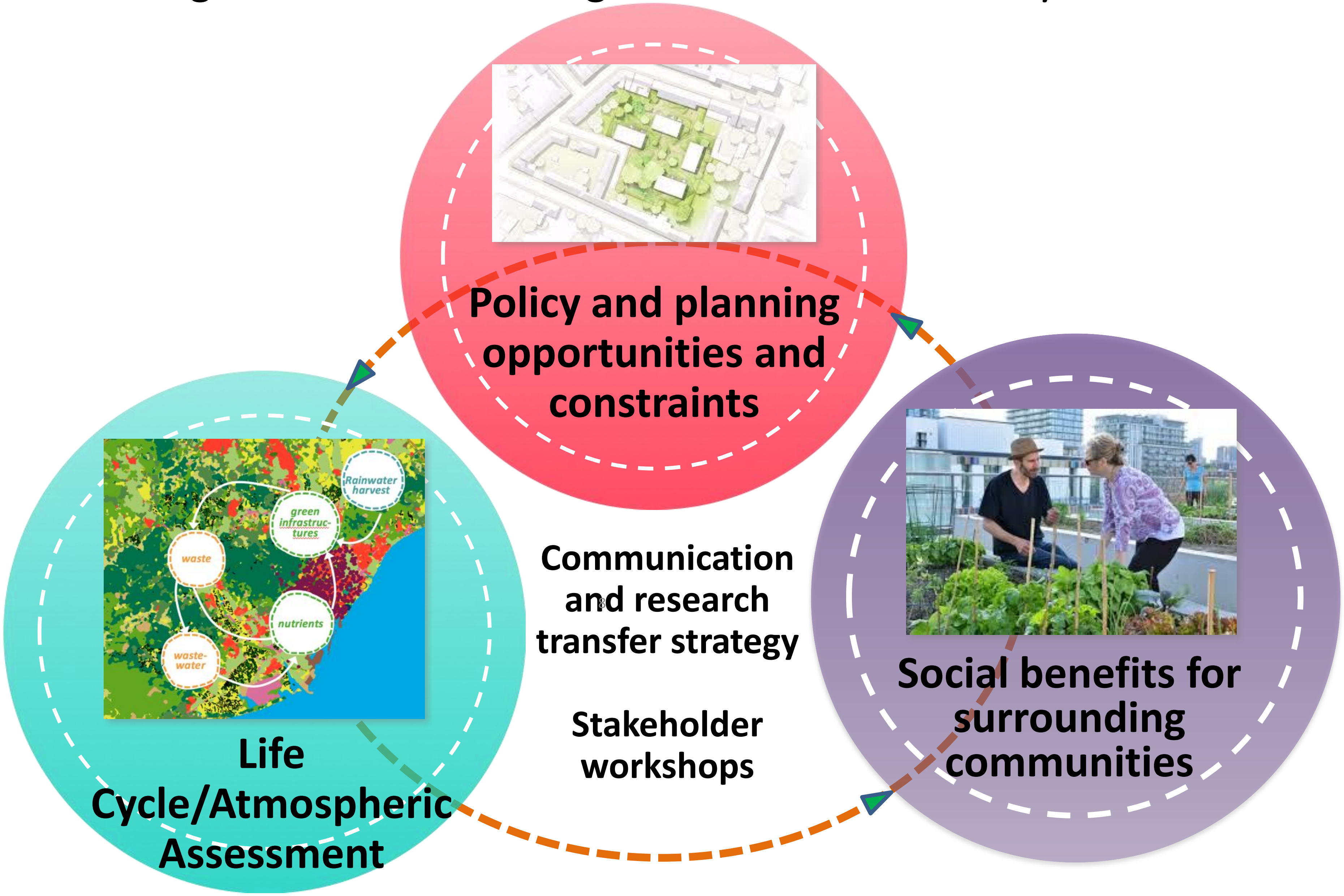


URBAG

Case Studies

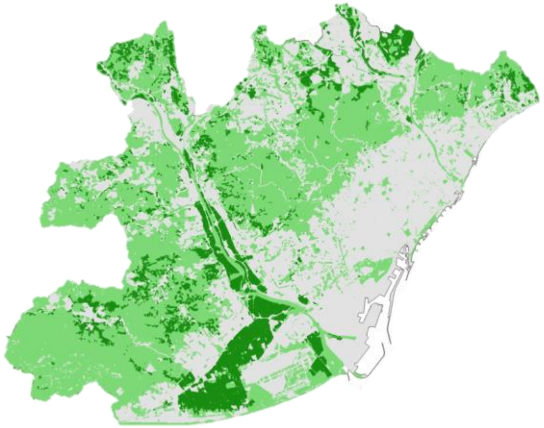
	Metropolitan Area of Barcelona	Oslo-Baerum-Nittedal
Total km^2	636	830
Built (%)	34	18
Green (%)	31	65
Agricultural (%)	23	8
Wetlands (%)	0.72	4.6
Population	3.5 million	0.8 million
Waste/cap (kg)	452	433
Wastewater/cap/day (L)	250	550
Green infrastructure policy	Programme for Promoting Urban Green Infrastructures	Urban Ecology Programme 2011-2026
Urban Policy	Urban Master Plan of Barcelona (Pla Director Urbanístic Metropolità de Barcelona)	Oslo’s Municipal Master Plan (Kommuneplan for Oslo)

Integrated assessment of green infrastructure analysis.



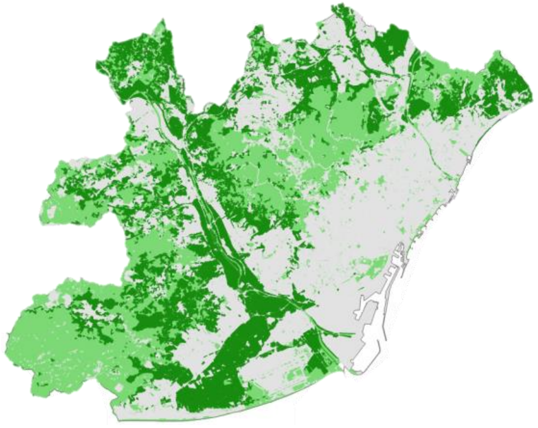
Urban agriculture in the Metropolitan Area of Barcelona

Current



Agriculture	8%
Other green	45%
Urban	47%

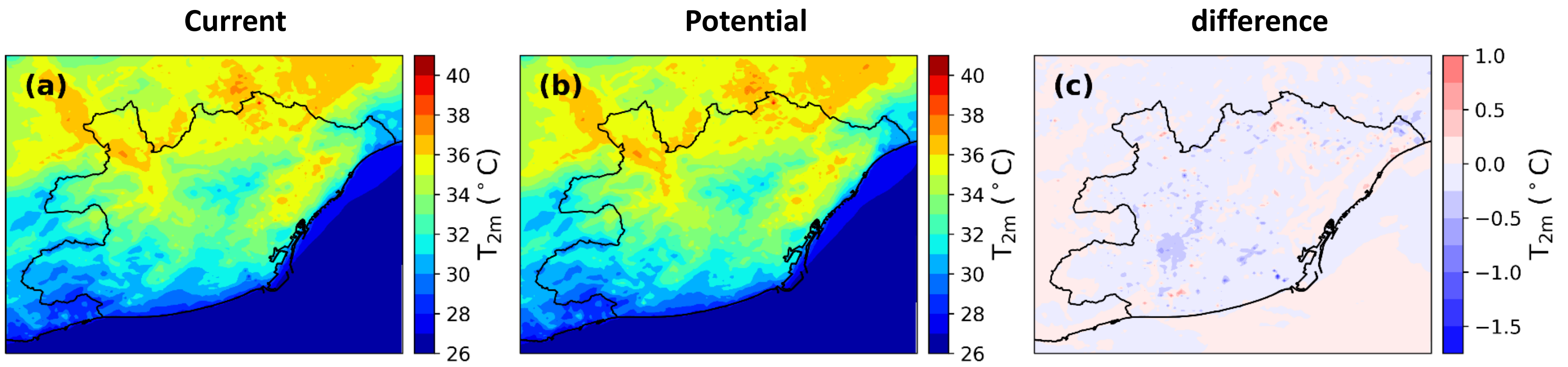
Potential



Agriculture	20%
Other green	34%
Urban	46%

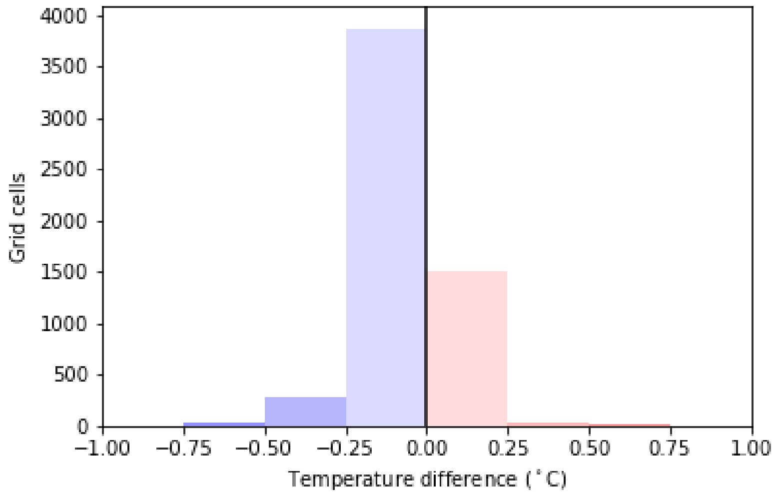
Urban agriculture: cooling belt?

Hourly average 2m temperature between 1 and 4pm during heat wave 2015



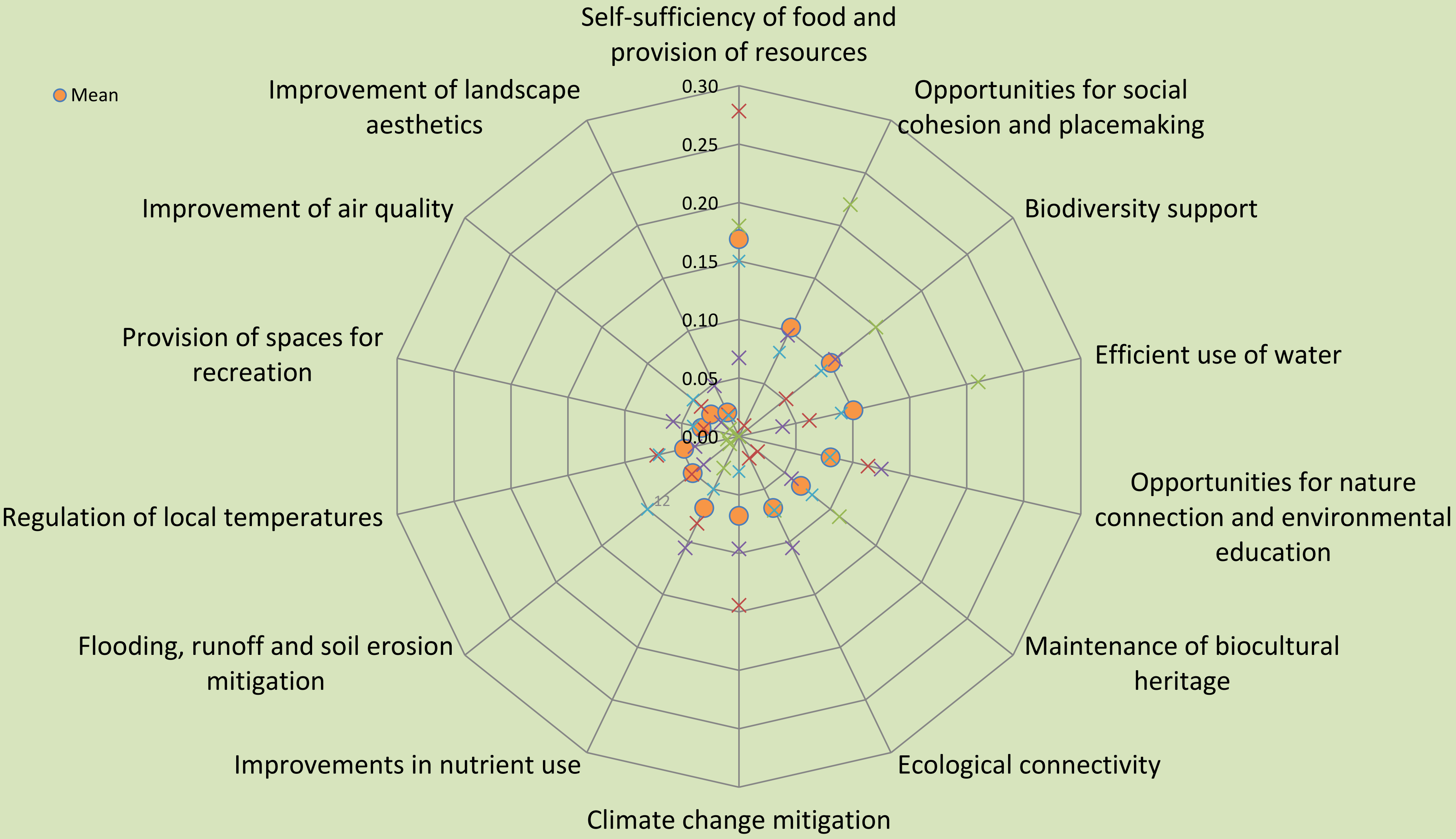
Maximum local reduction of 1.73 ^{o}C.

Maximum local increase of 0.79 ^{o}C.

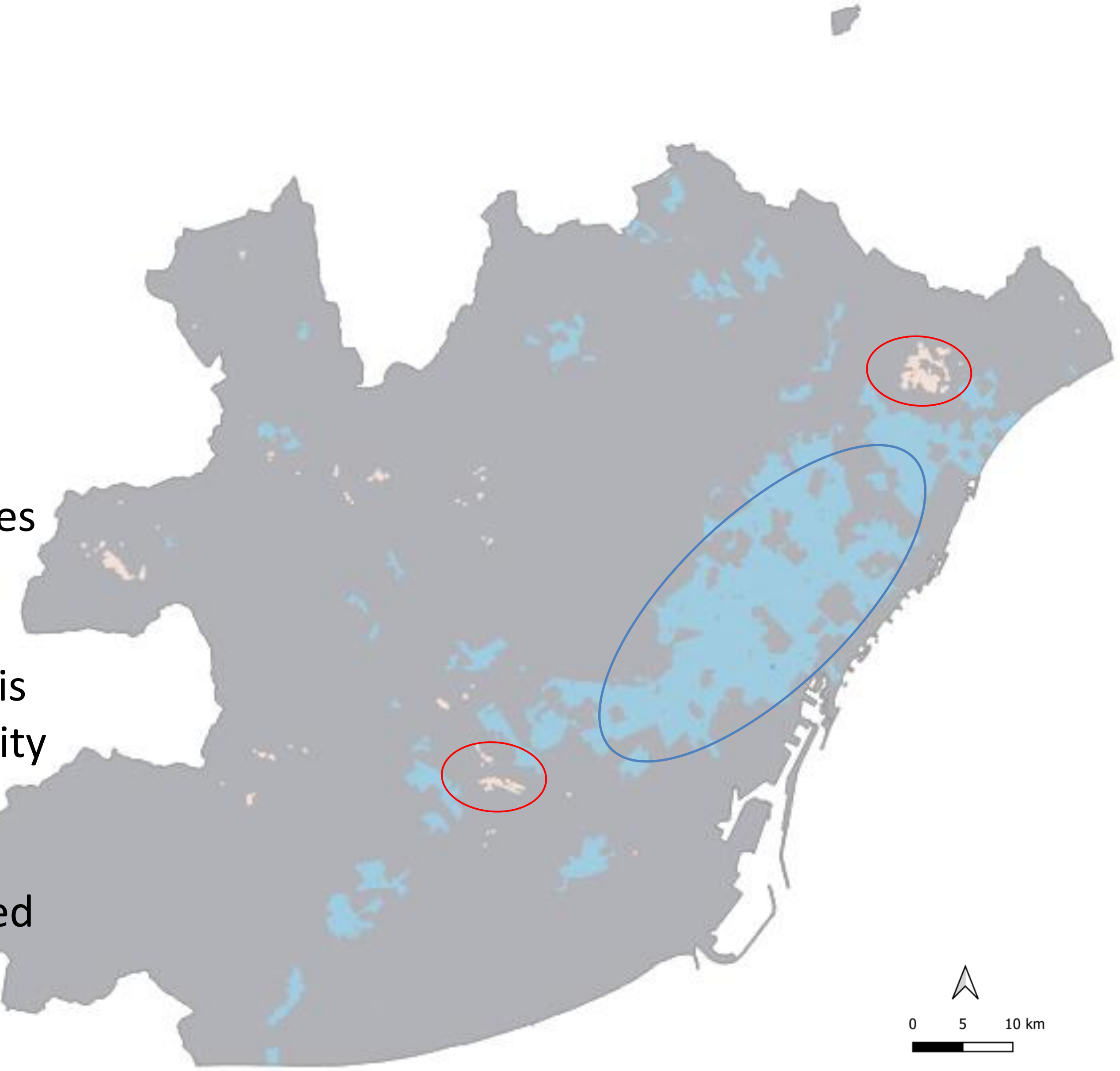


- Define and prioritize a list of criteria (i.e. local crop production, thermal regulation).
- Define and discuss strategies to promote urban agriculture.

How participants prioritzed the criteria for the vulnerability assessment



Urban agriculture: aggregated vulnerabilities

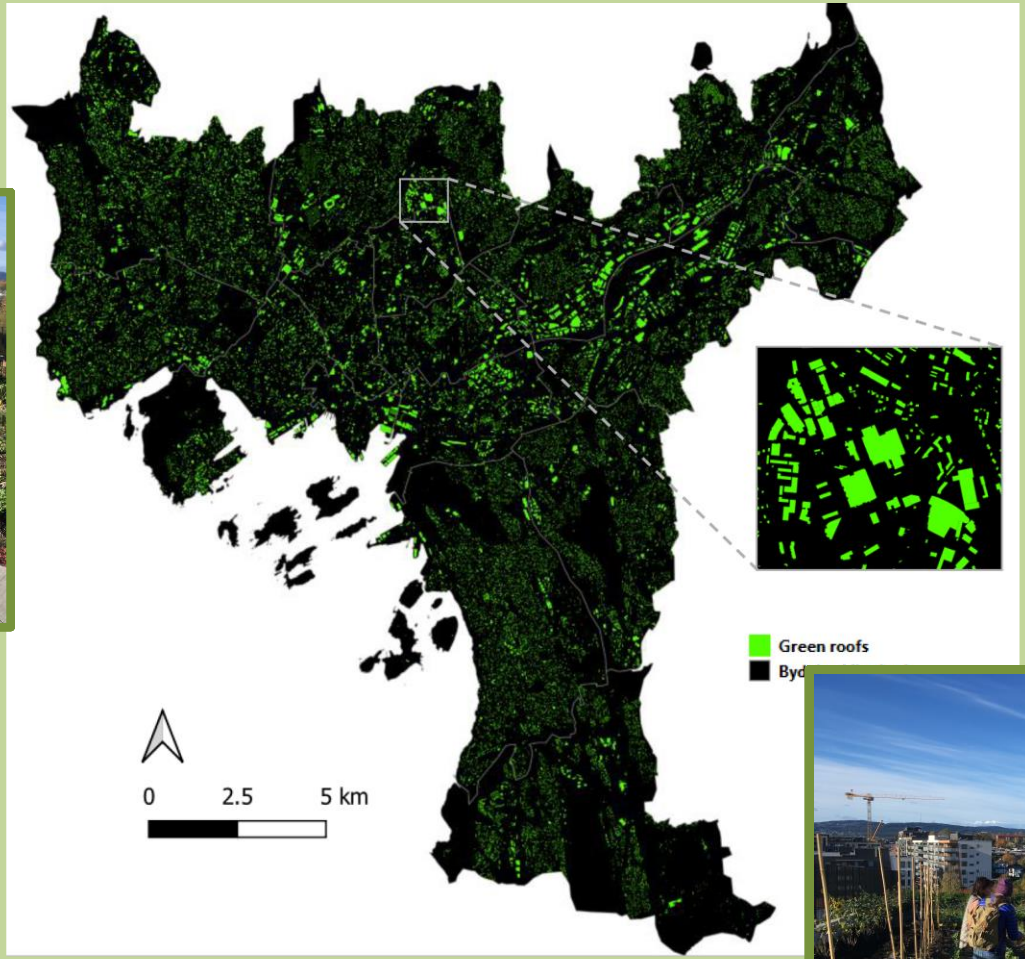


- reduces overall vulnerabilities
- Increases vulnerability in biodiversity
- Reduction in vulnerabilities is concentrated in Barcelona city with highest population density
- Local crop production ranked highest importance by stakeholders

Green roofs in Oslo

Objectives of the Stakeholder Workshop

- To determine the relevance of the impacts resulting from the implementation of green roofs in the Municipality of Oslo on local and global vulnerabilities.
- To assess whether policy-making strategies could benefit from the results obtained in the green roof assessment.



Thank you for your attention

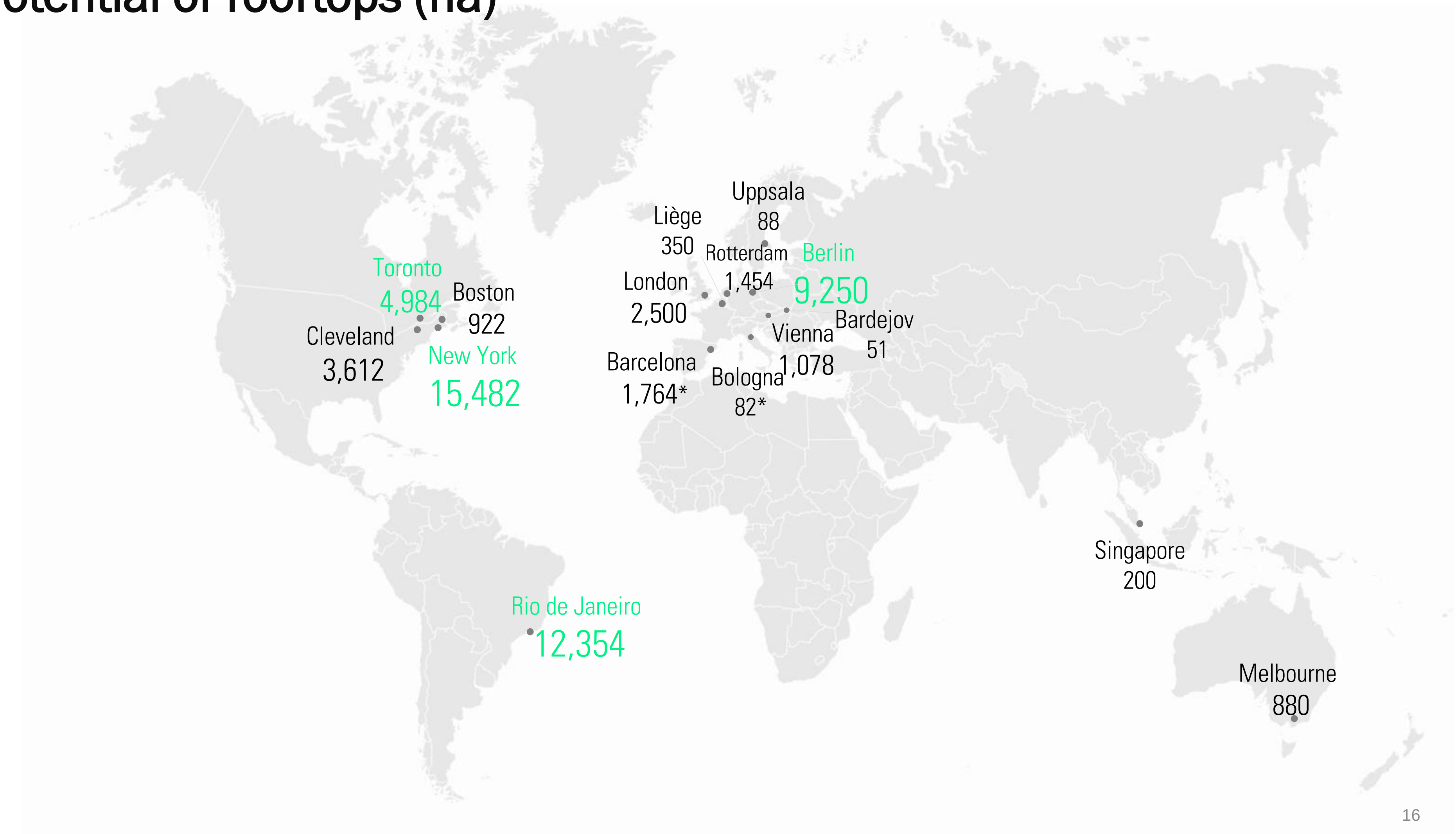
gara.villalba@uab.cat

Please visit

https://urbag.eu

URBAG Integrated System Analysis of Urban Vegetation and Agriculture

Potential of rooftops (ha)



Integrated assessment of green roofs: vulnerability assessment

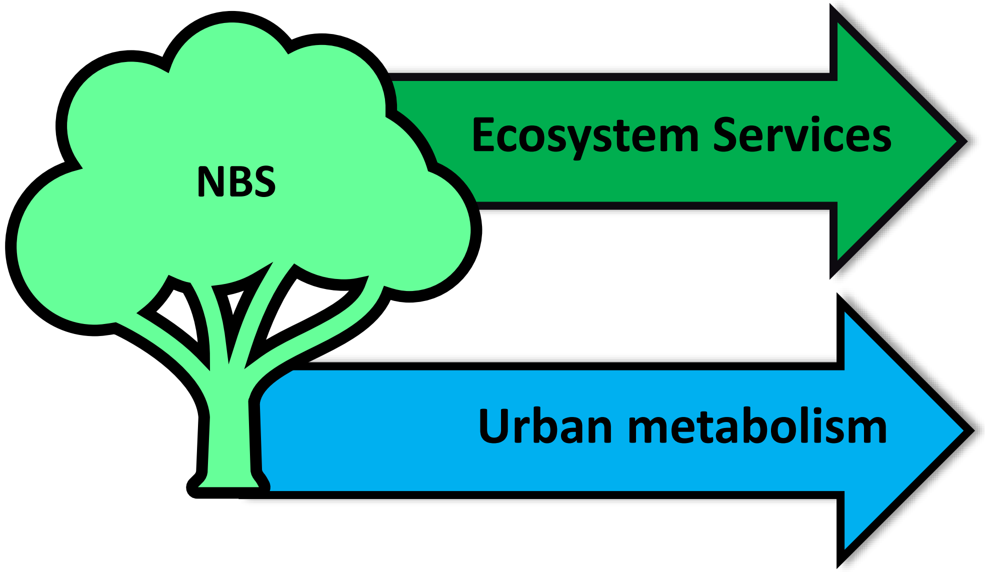
Online workshop
January 29th, 2024

David A. Camacho

Institute of Environmental Science and Technology (ICTA)

Background

NBS = Nature-based solution



the various ways in which humans can benefit from natural ecosystems

how NBS affect the resources employed, created and emitted by cities for maintaining itself

However, these approaches:
- are not integrated
- they do not recognize the unequal need for Nature-based solutions across the city

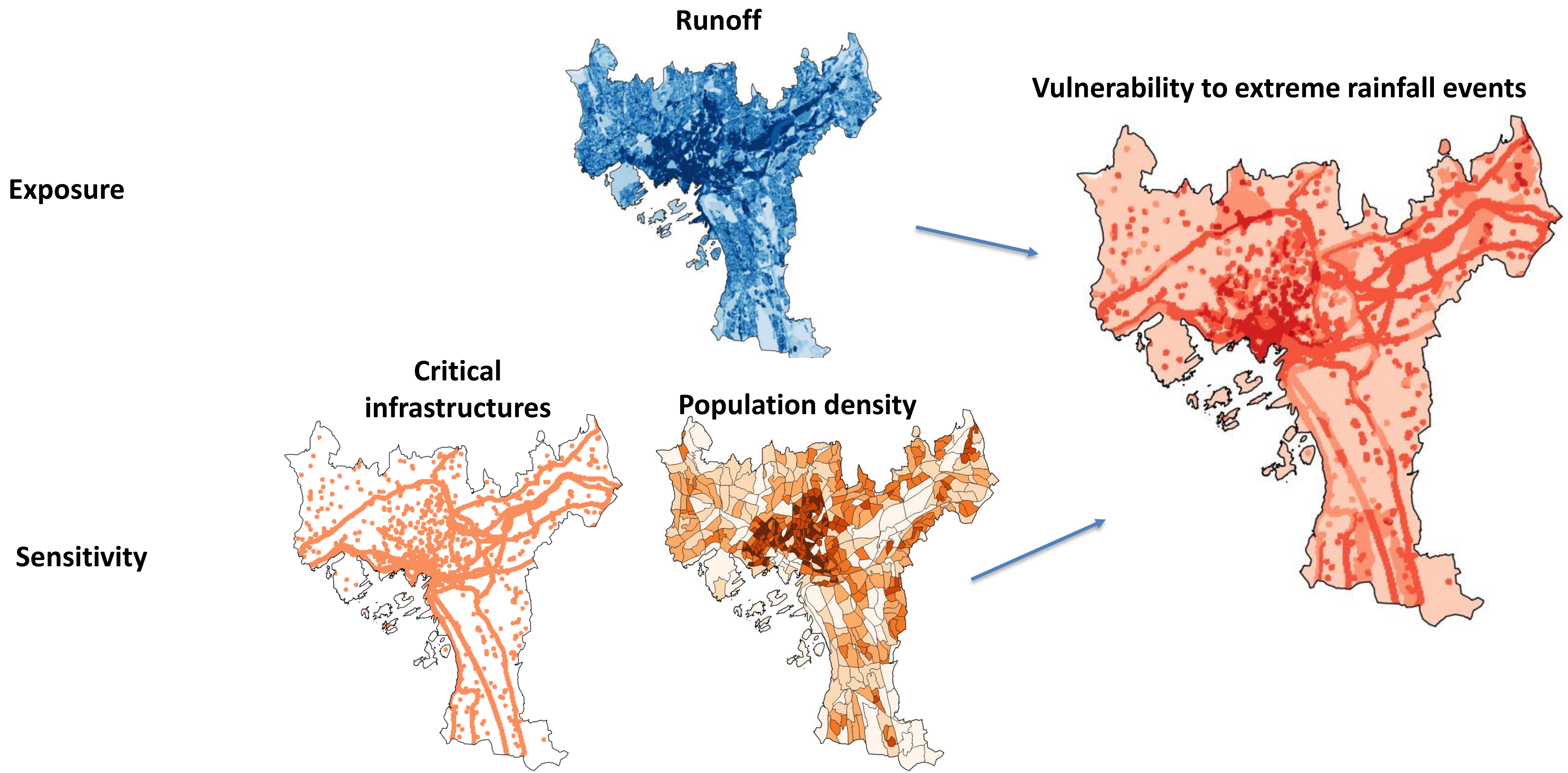
NBS-vulnerability framework

***Vulnerability**: susceptibility to harm of both social and ecological systems.*

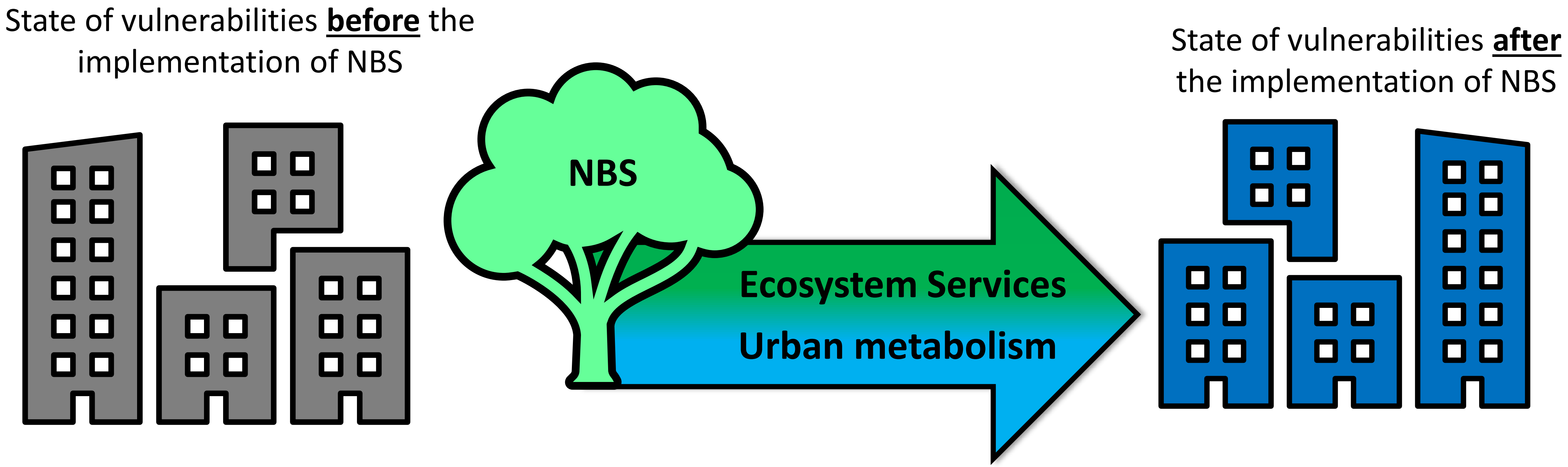
Product of:

exposure (proximity to hazards)
sensitivity (extent of the impacts of hazards)

NBS-vulnerability framework example



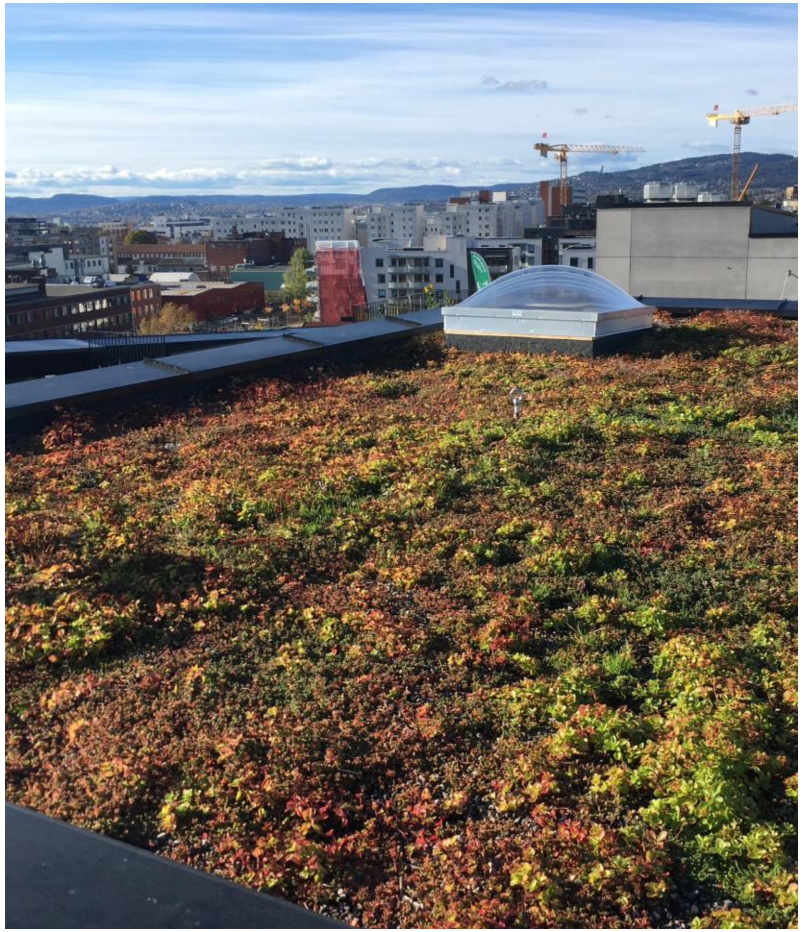
NBS-vulnerability framework



Case study

Case study: green roofs in Oslo

NBS: extensive green roofs



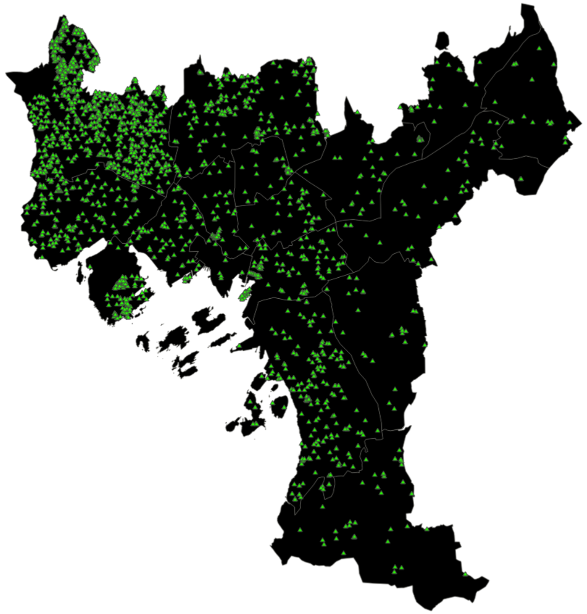
Implemented within Oslo limits (Oslo Kommune)

Case study: Green roofs in the Oslo Municipality

Scenario 0
Reference

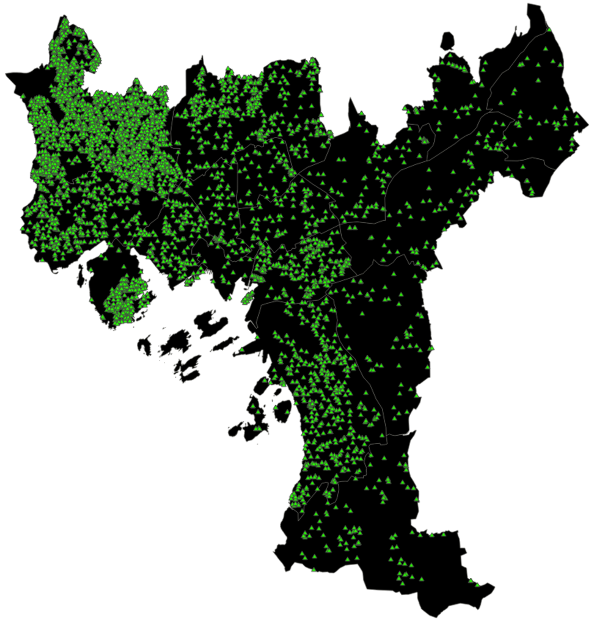
928 green roofs
18.9 ha

Scenario 1
Green roof strategy



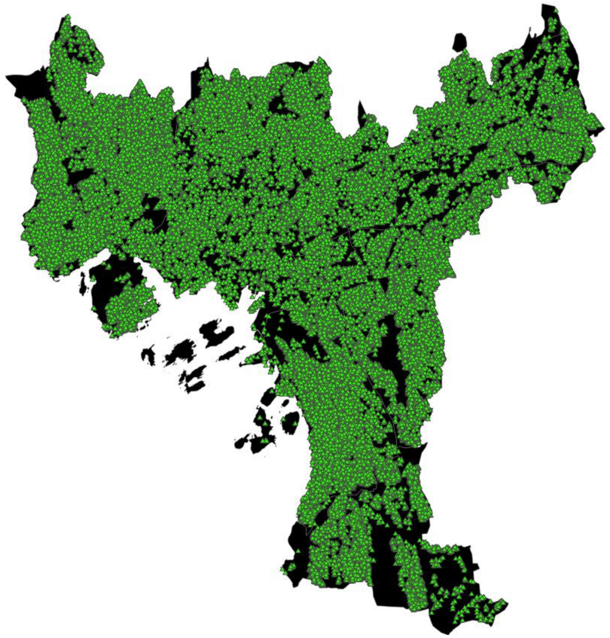
2,030 green roofs
41.5 ha

Scenario 2
Ambitious



3,550 green roofs
72.9 ha

Scenario 3
Maximization

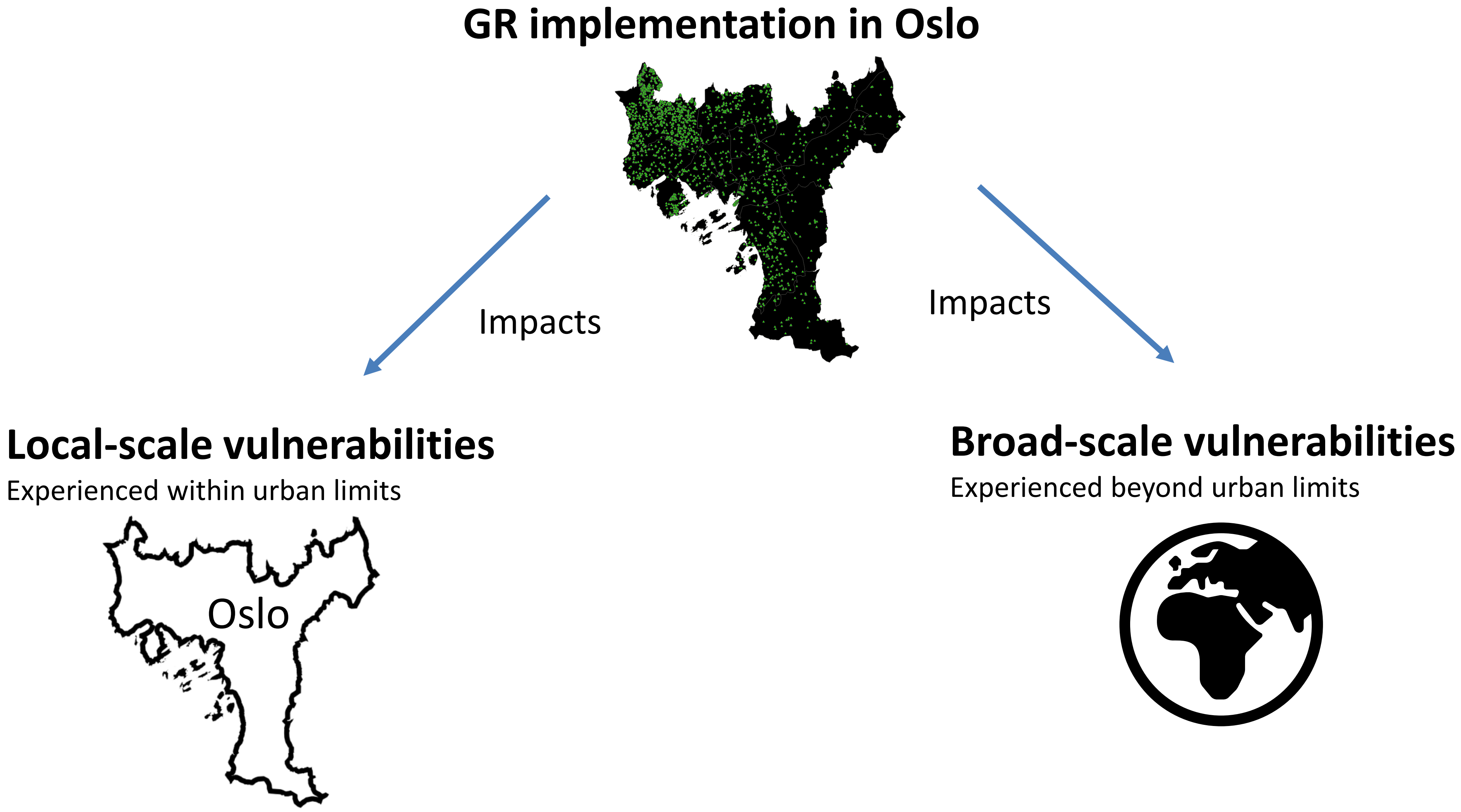


56,786 green roofs
1,039.1 ha

based on the availability of rooftops complying with criteria (area and slope)

Application of NBS-Vulnerability framework

NBS-vulnerability framework



Local-scale vulnerabilities

Experienced within urban limits

To heat

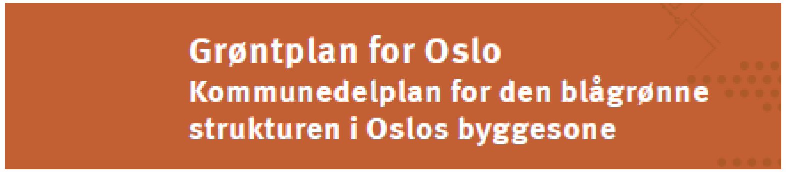
To heavy rainfall events

To lack of opportunities for interacting with natural environments

To lack of habitats for pollinators

To air pollution

Urban policies



Broad-scale vulnerabilities

Experienced beyond urban limits

To climate change

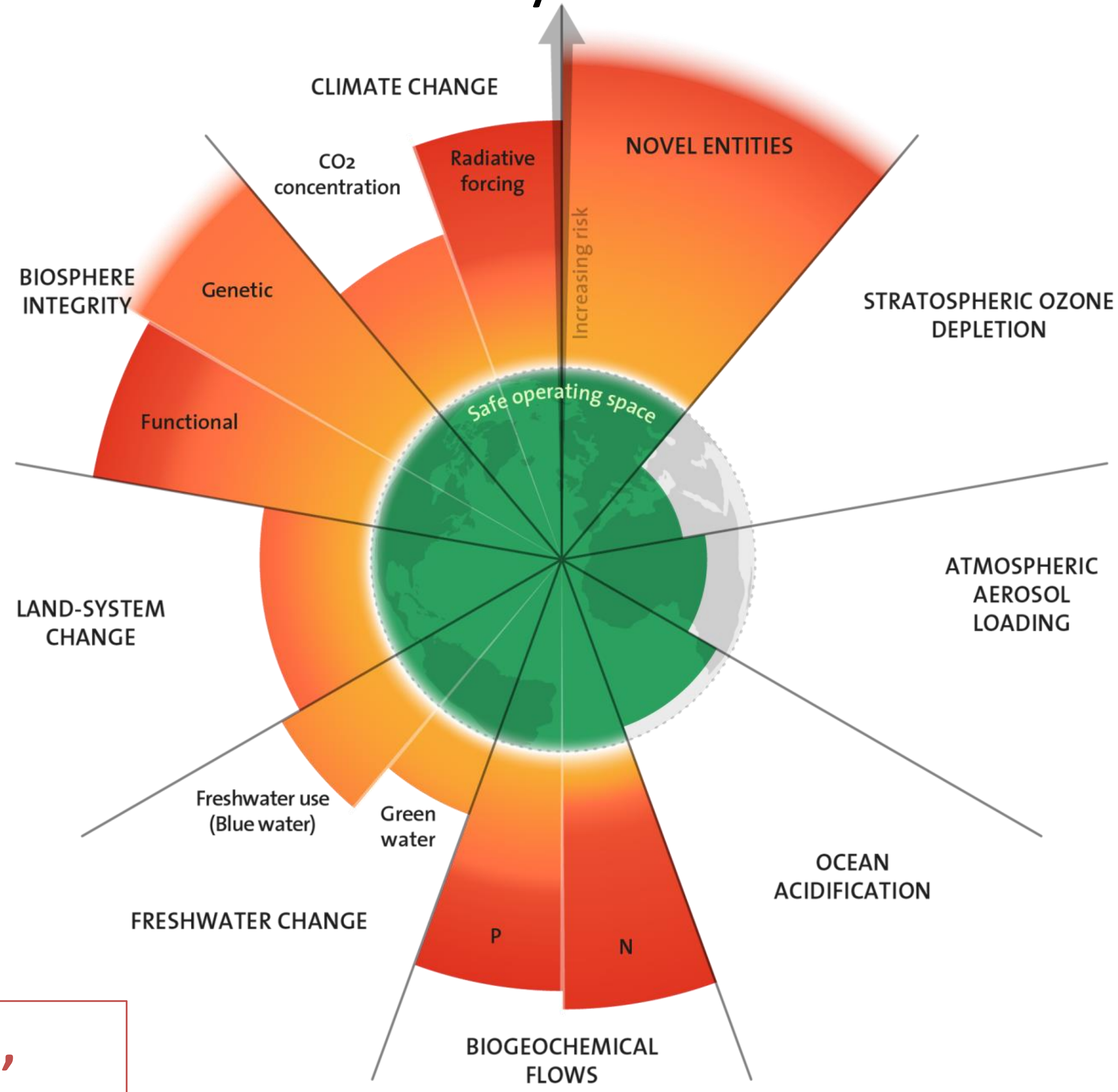
To stratospheric ozone depletion

To chemical pollution

To changes in biogeochemical flows

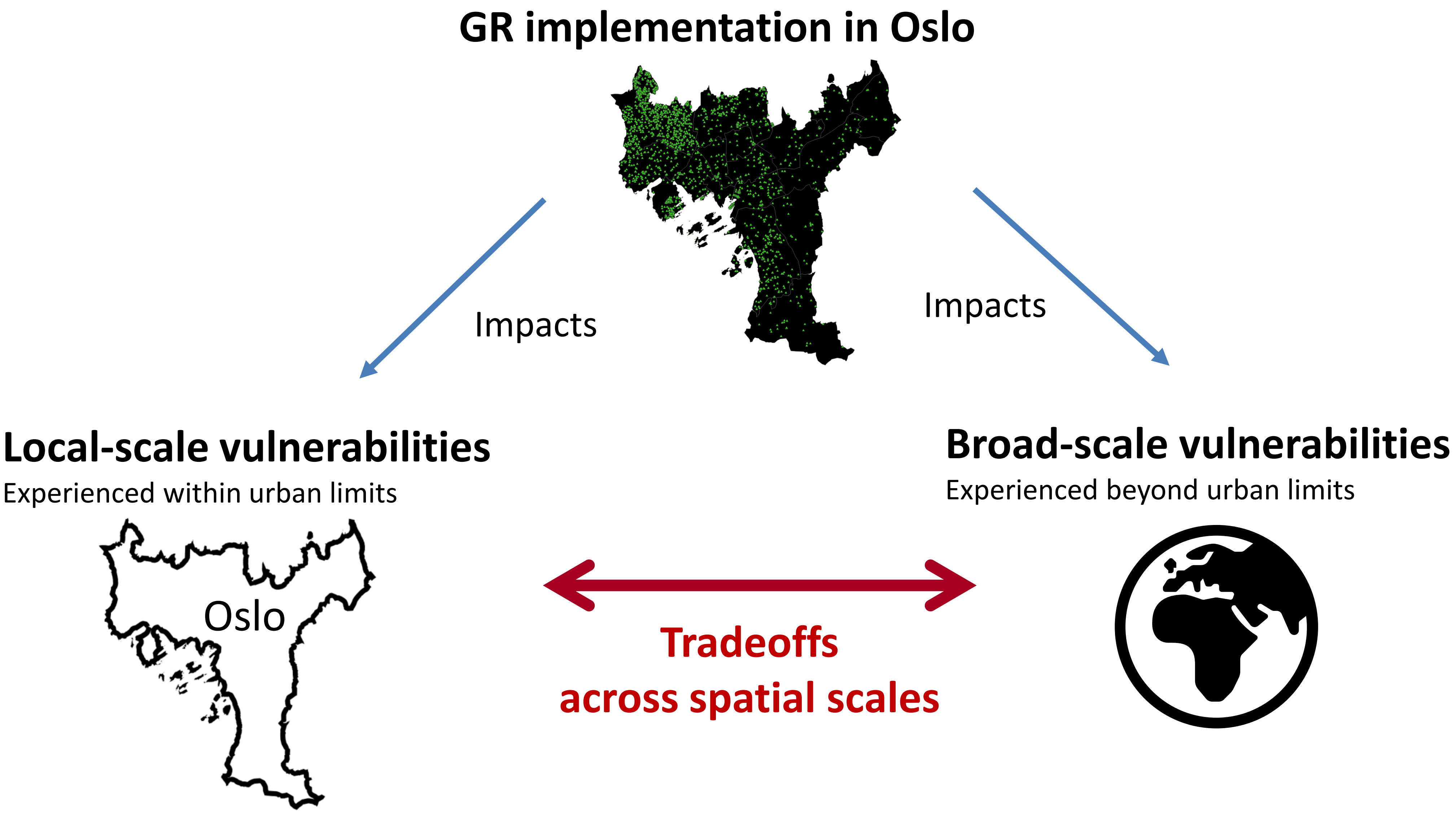
Vulnerabilities affected by the production, installation, maintenance and disposal of GR

Planetary boundaries



Stockholm Resilience Centre, 2023

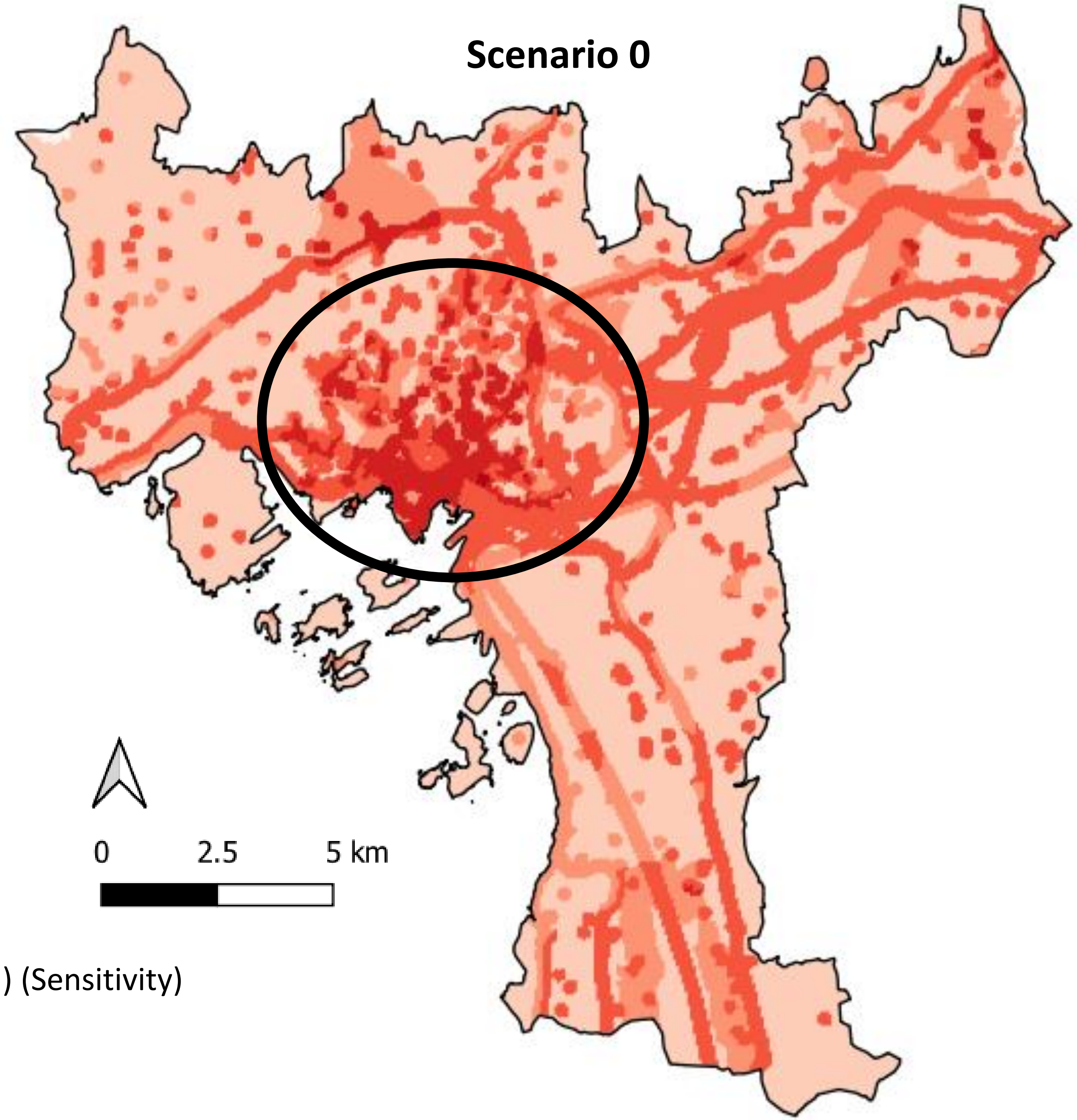
NBS-vulnerability framework



Results

Local-scale vulnerabilities

Local-scale vulnerabilities: results



Vulnerability to heavy rainfall events

No vulnerability

High vulnerability

Indicators considered

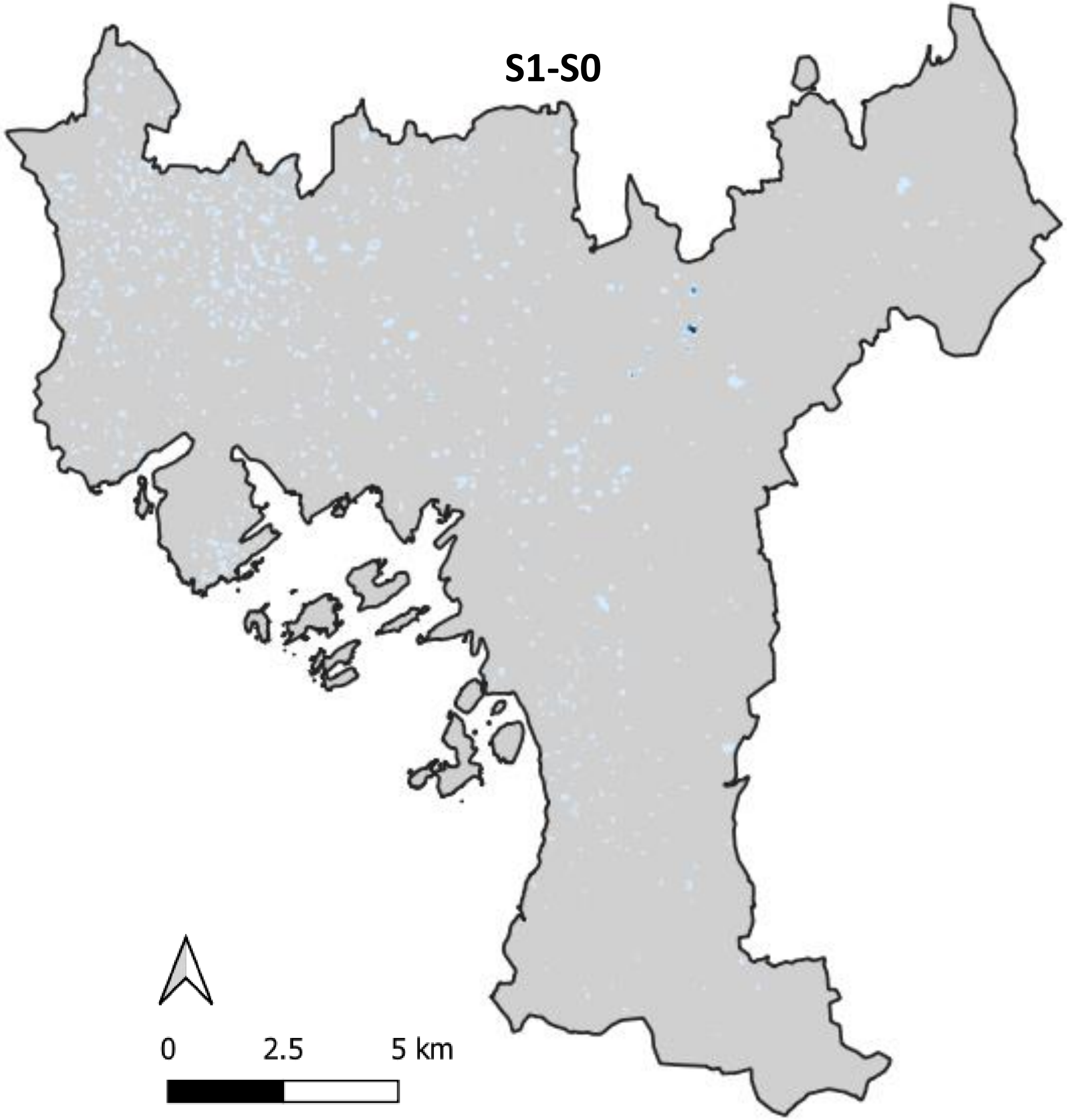
- Runoff coefficients during heavy rainfall (Exposure)
- Critical infrastructures (roads, police stations, train stations, etc.) (Sensitivity)
- Population density (Sensitivity)
- Elderly population density (Sensitivity)
- Low-income households (Sensitivity)

Local-scale vulnerabilities: results

Vulnerability to heavy rainfall events

Runoff reduction (liters/second)

- 89 - 67
- 67 - 45
- 45 - 22
- 22 - 0.1
- 0



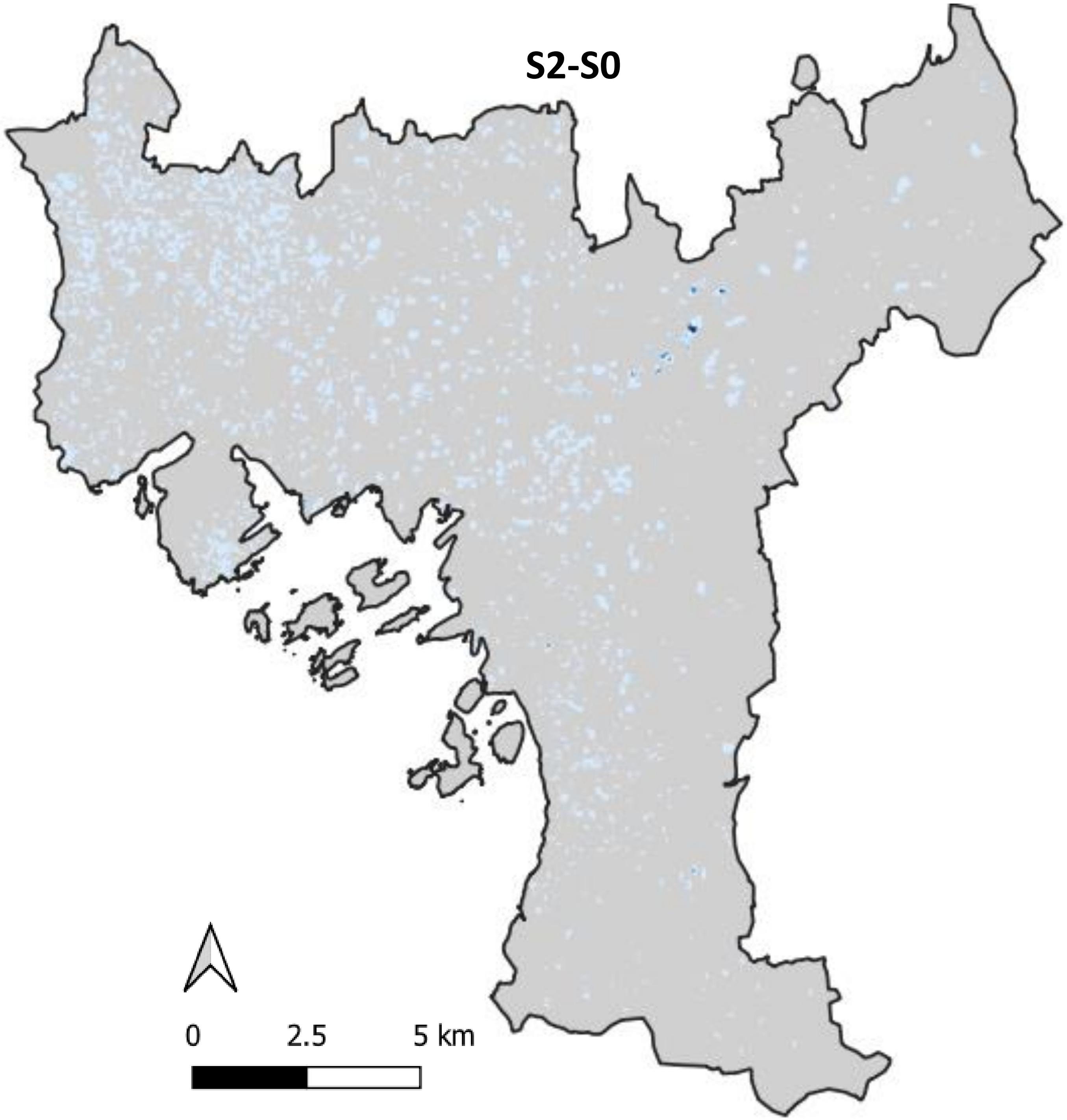
Local-scale vulnerabilities: results

Vulnerability to heavy rainfall events

Exposure

Runoff reduction (liters/second)

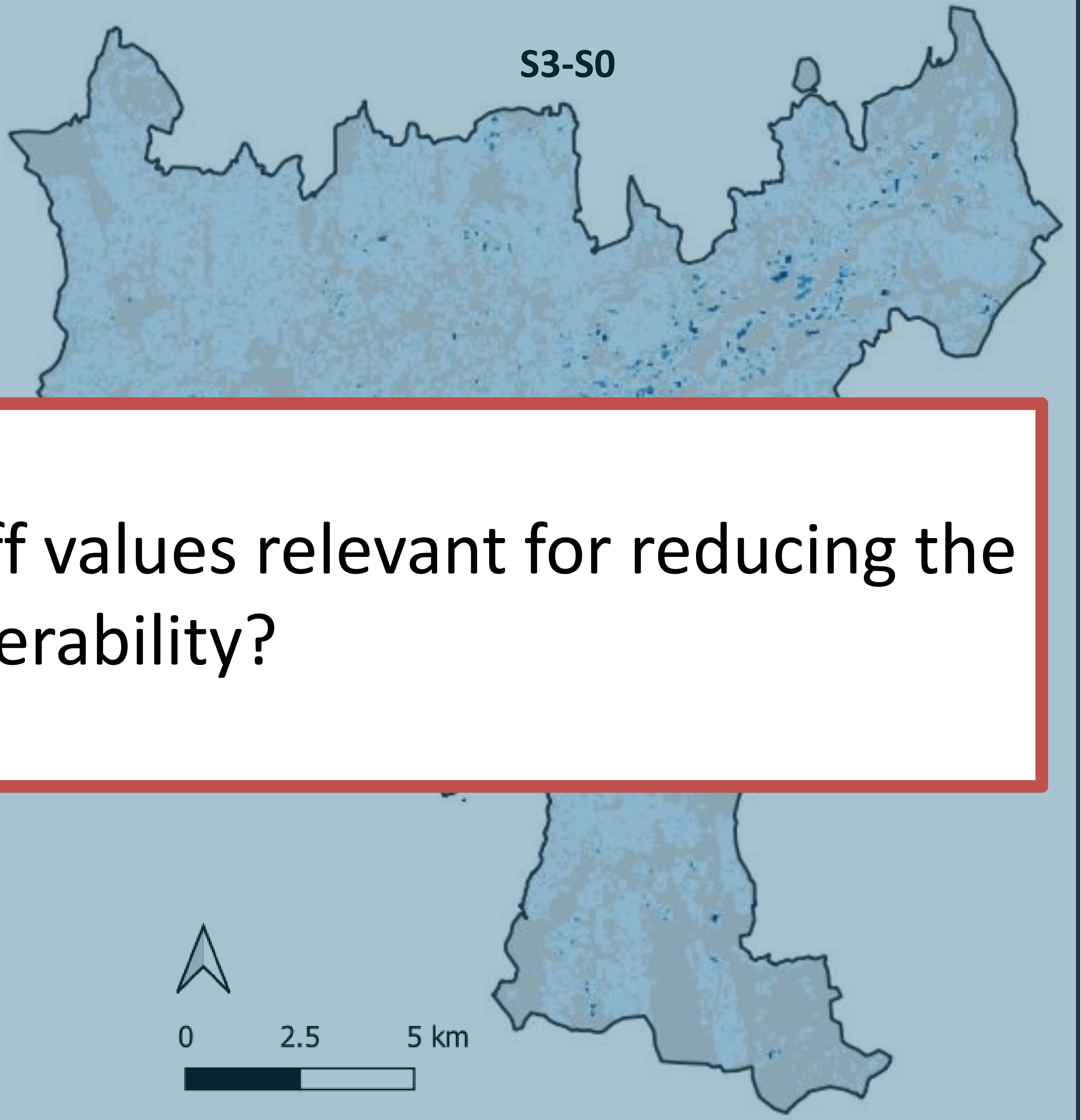
- 89 - 67
- 67 - 45
- 45 - 22
- 22 - 0.1
- 0



Local-scale vulnerabilities: results

Vulnerability to heavy rainfall events

Runoff reduction (liters/second)



Are these decreases in runoff values relevant for reducing the vulnerability?

Oslo

Oslo kommune

Overvannsveileder

Retningslinjer og veiledning for overvannshåndtering i Oslo kommune

Guidelines for stormwater management in Oslo

2023

Threshold reference value that helps to determine the degree of exposure (e.g., safe amount of runoff)

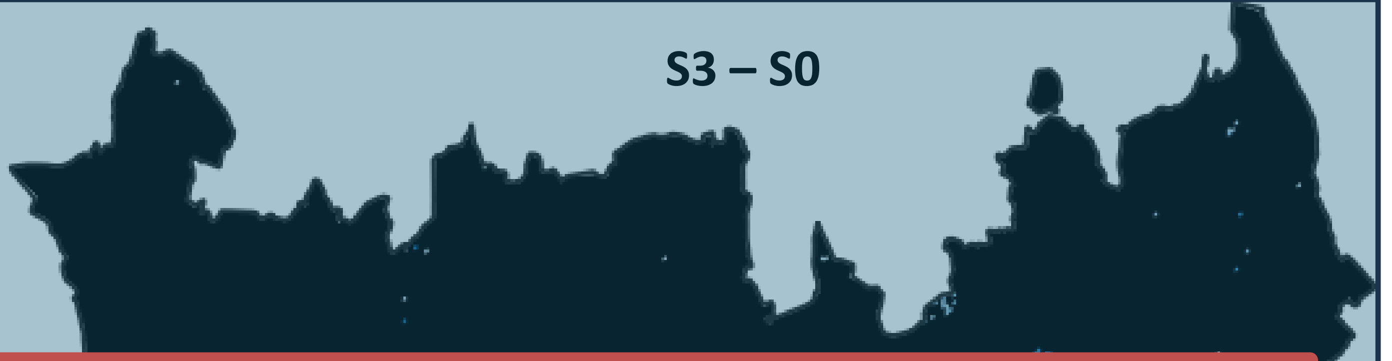
Maximum discharge quantity

Vulnerability **decreases** when the runoff levels of an area are reduced below the maximum discharge limits (due to the implementation of GR)

Vulnerability **does not decrease** when the runoff levels of an area remain above the maximum discharge limits (even after the implementation of GR)

Local-scale vulnerabilities: results

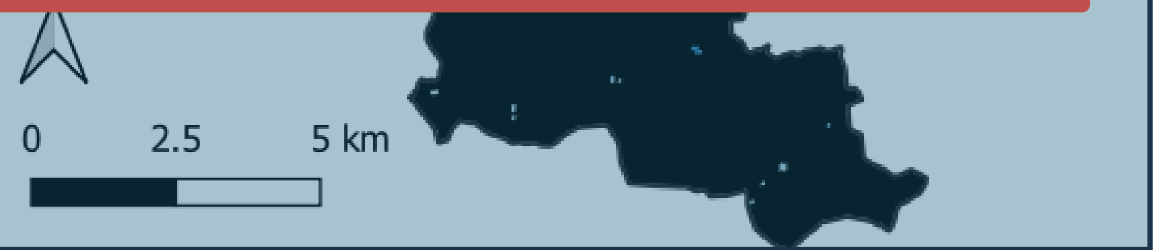
Vulnerability to heavy rainfall events



Reduced vulnerability

GR are indeed helpful for dealing with heavy rainfall events, but they are not capable of reducing the overall vulnerability by themselves

- Critical infrastructures (roads, police stations, train stations, etc.) (SEN)
- Population density (SEN)
- Elderly population density (SEN)
- Low-income households (SEN)

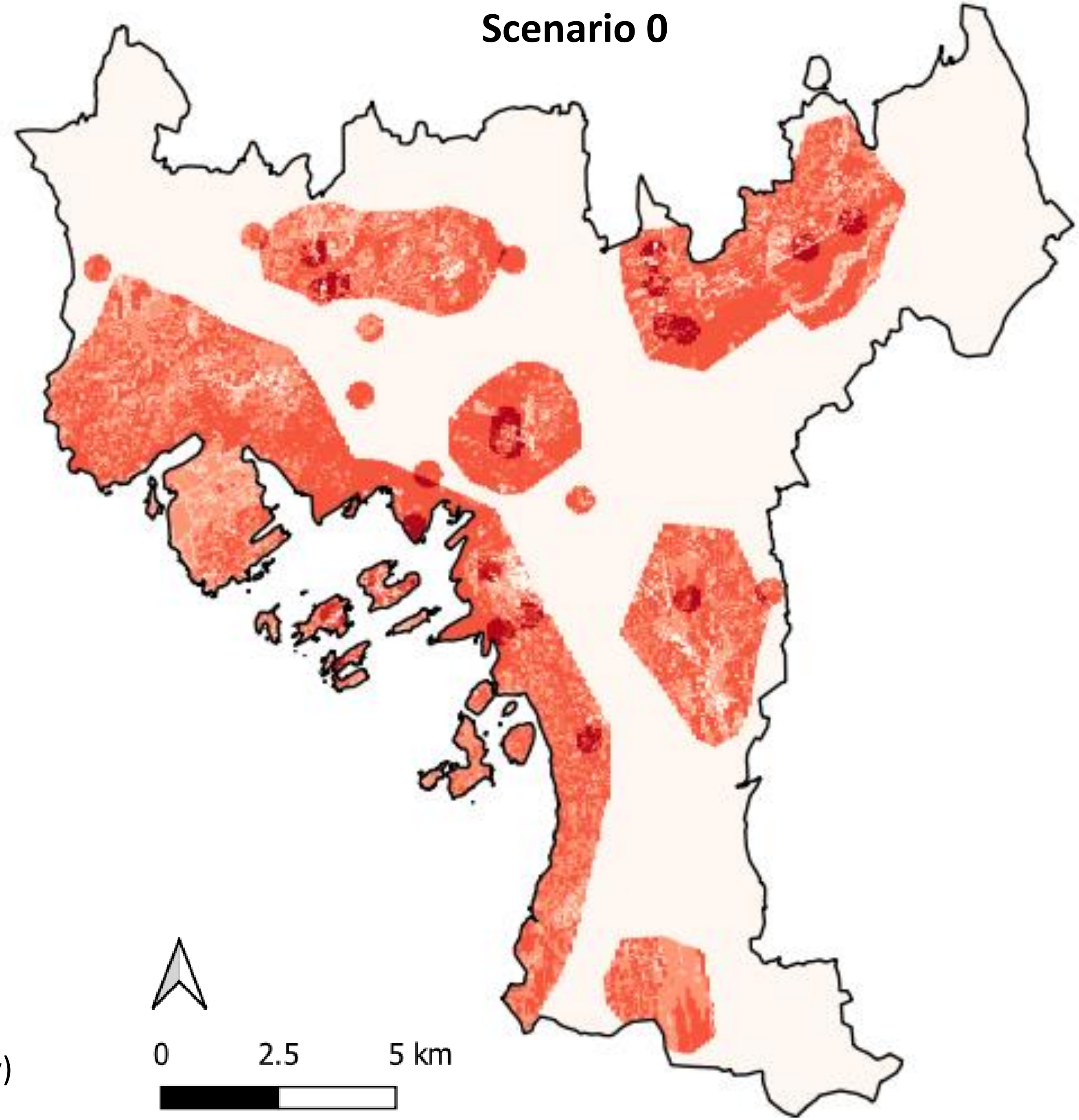


Local-scale vulnerabilities: results

Vulnerability to lack of habitats for pollinators

No vulnerability

High vulnerability



Indicators considered

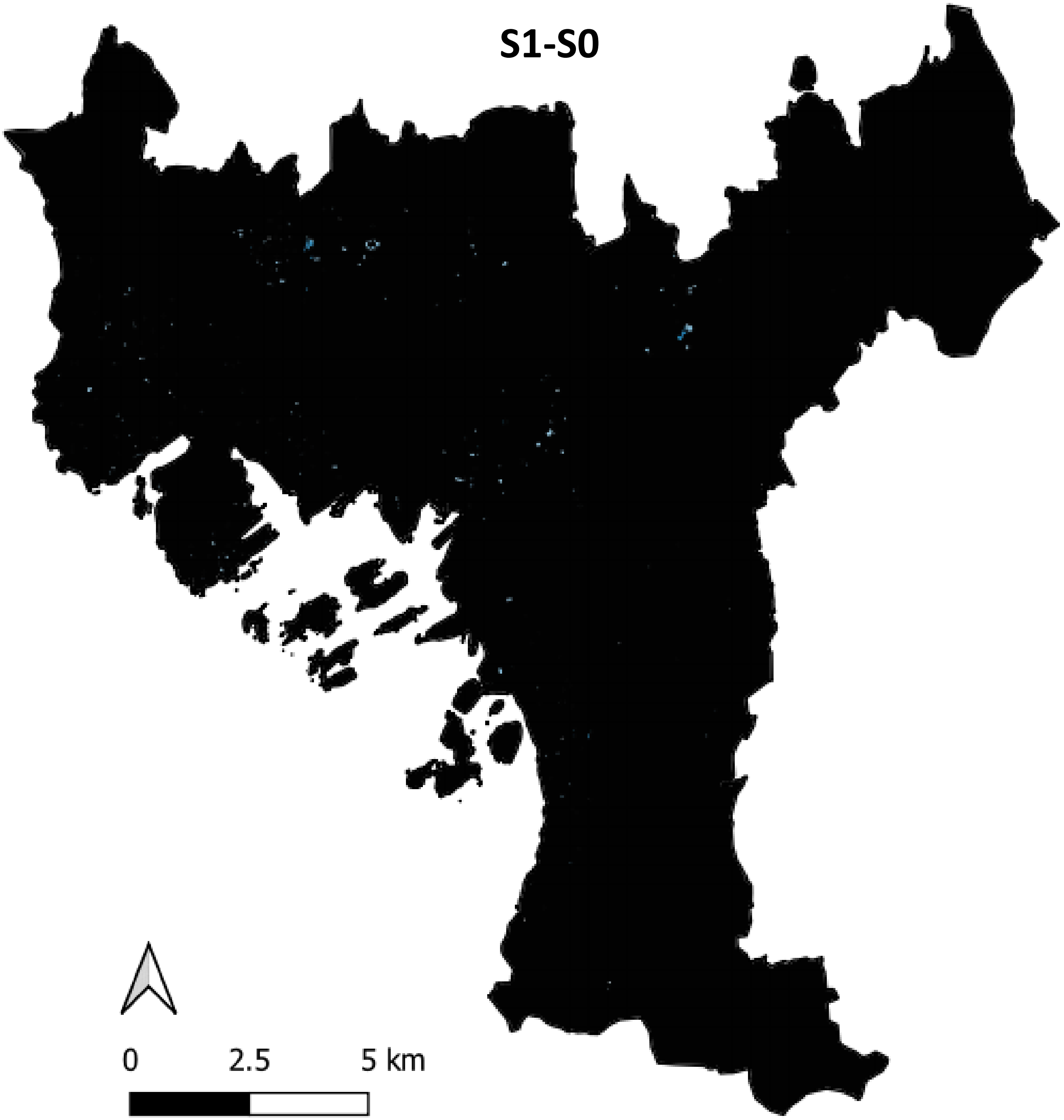
- Pollinator habitat suitability (Exposure)
- Proposed precautionary zones for honeybee keeping (Sensitivity)
- Red-listed bee species (Sensitivity)

Local-scale vulnerabilities: results

Vulnerability to lack of habitats for pollinators

Reduced vulnerability

No change in vulnerability



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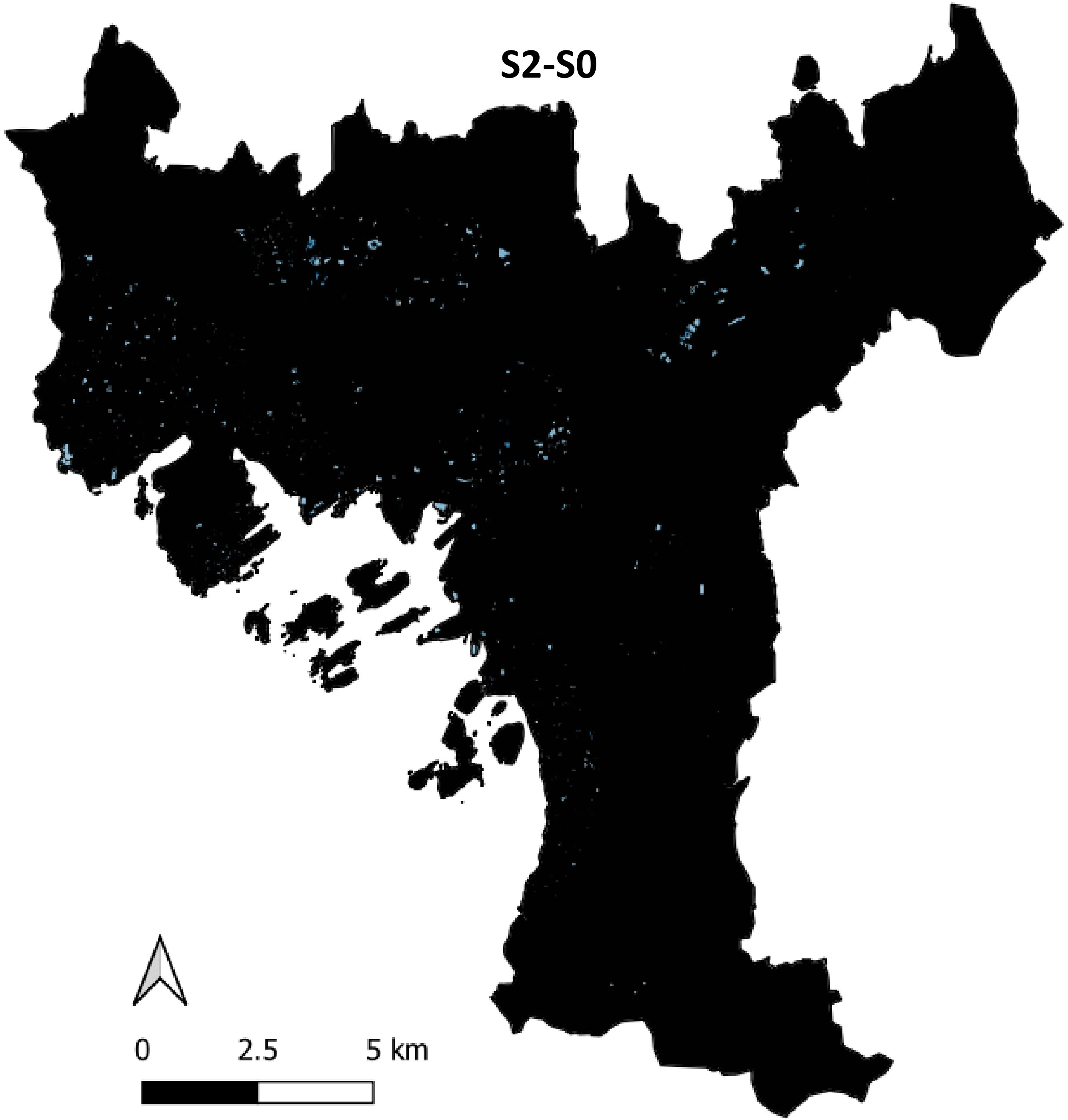
Local-scale vulnerabilities: results

Vulnerability to lack of habitats for pollinators

Reduced vulnerability

No change in vulnerability



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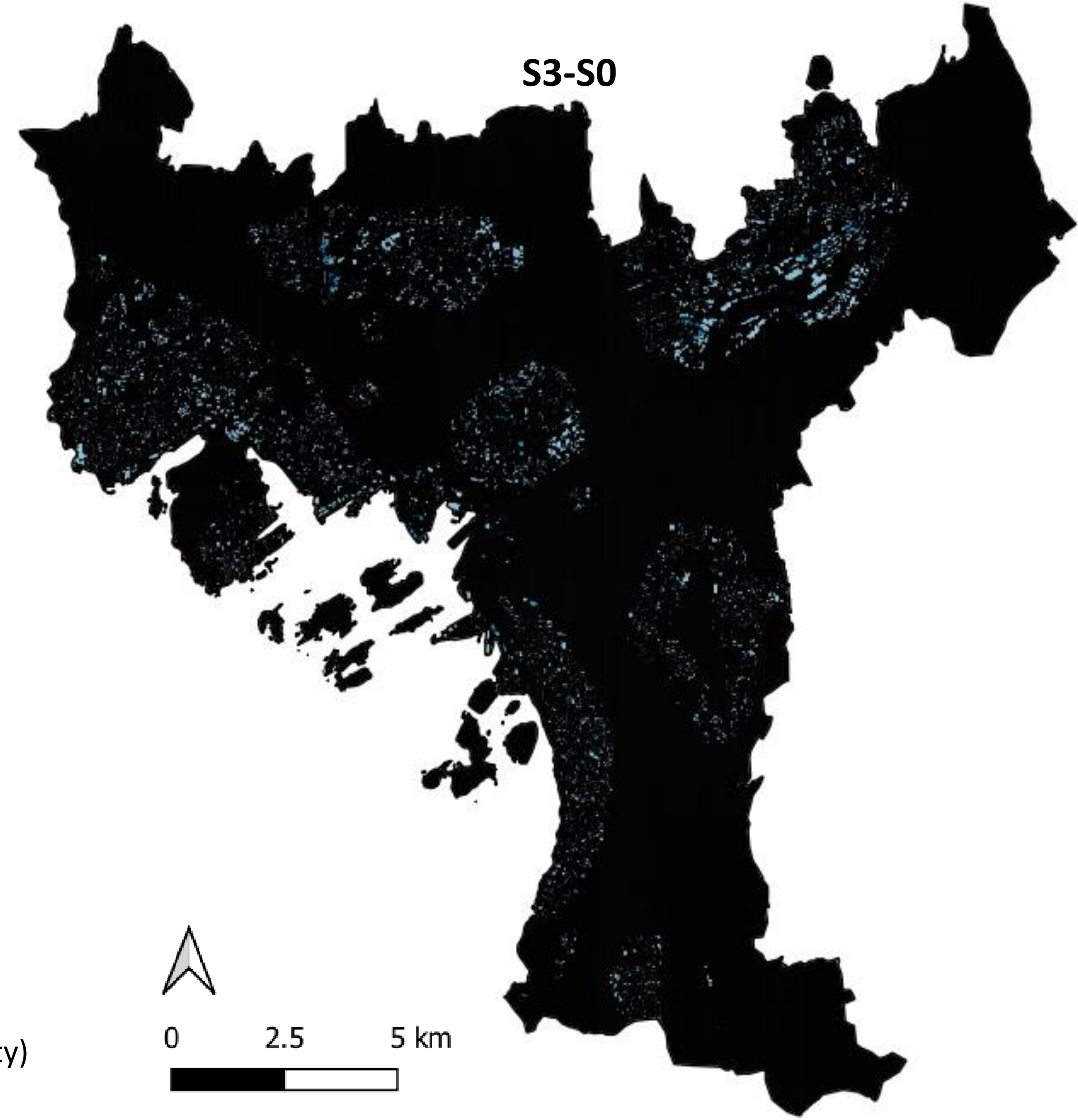
Local-scale vulnerabilities: results

Vulnerability to lack of habitats for pollinators

Reduced vulnerability

No change in vulnerability



Indicators considered

- Pollinator habitat suitability (Exposure)
- Proposed precautionary zones for honeybee keeping (Sensitivity)
- Red-listed bee species (Sensitivity)

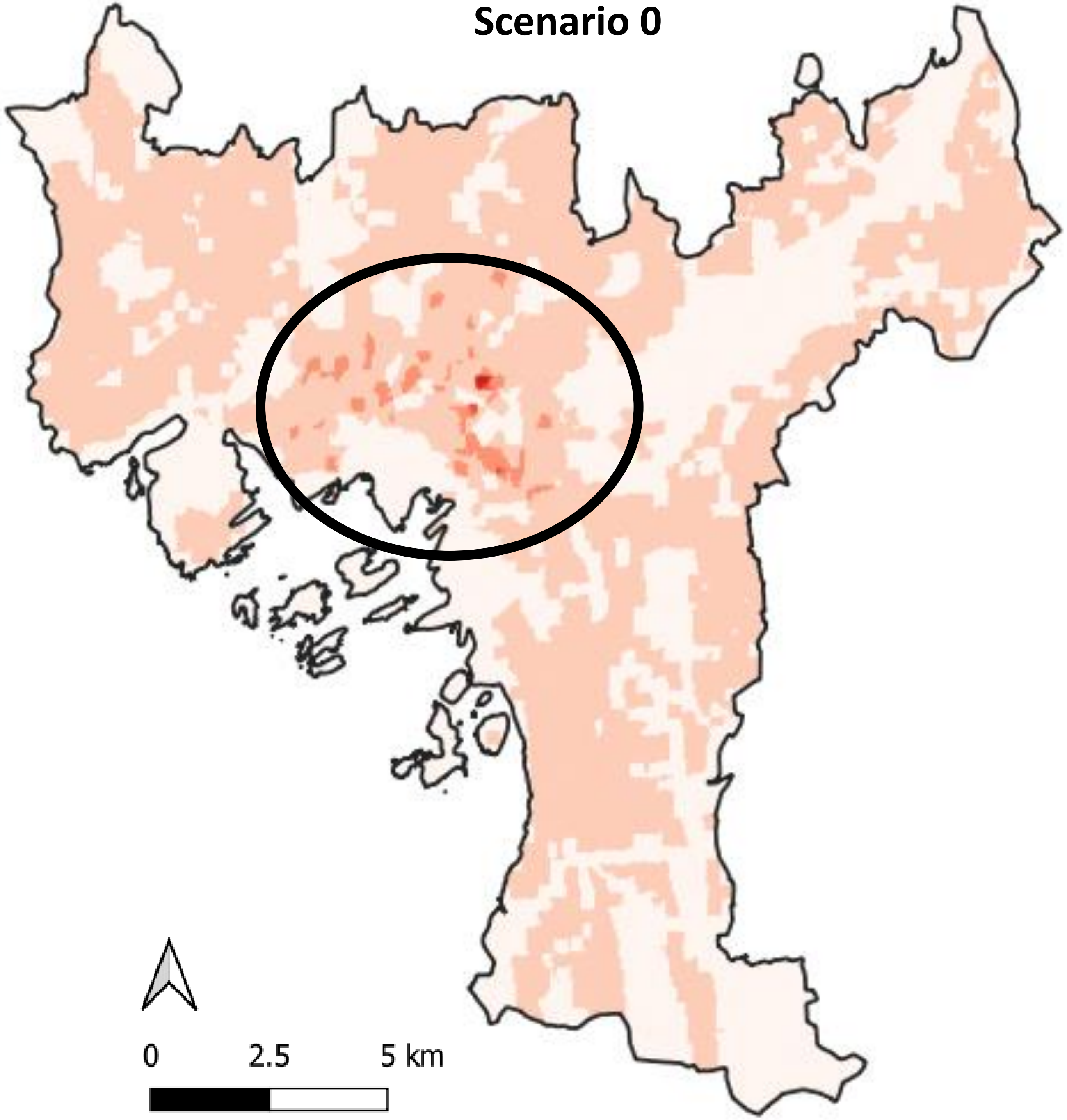
Local-scale vulnerabilities: results

Vulnerability to air pollution

No vulnerability

High vulnerability

Scenario 0



Indicators considered

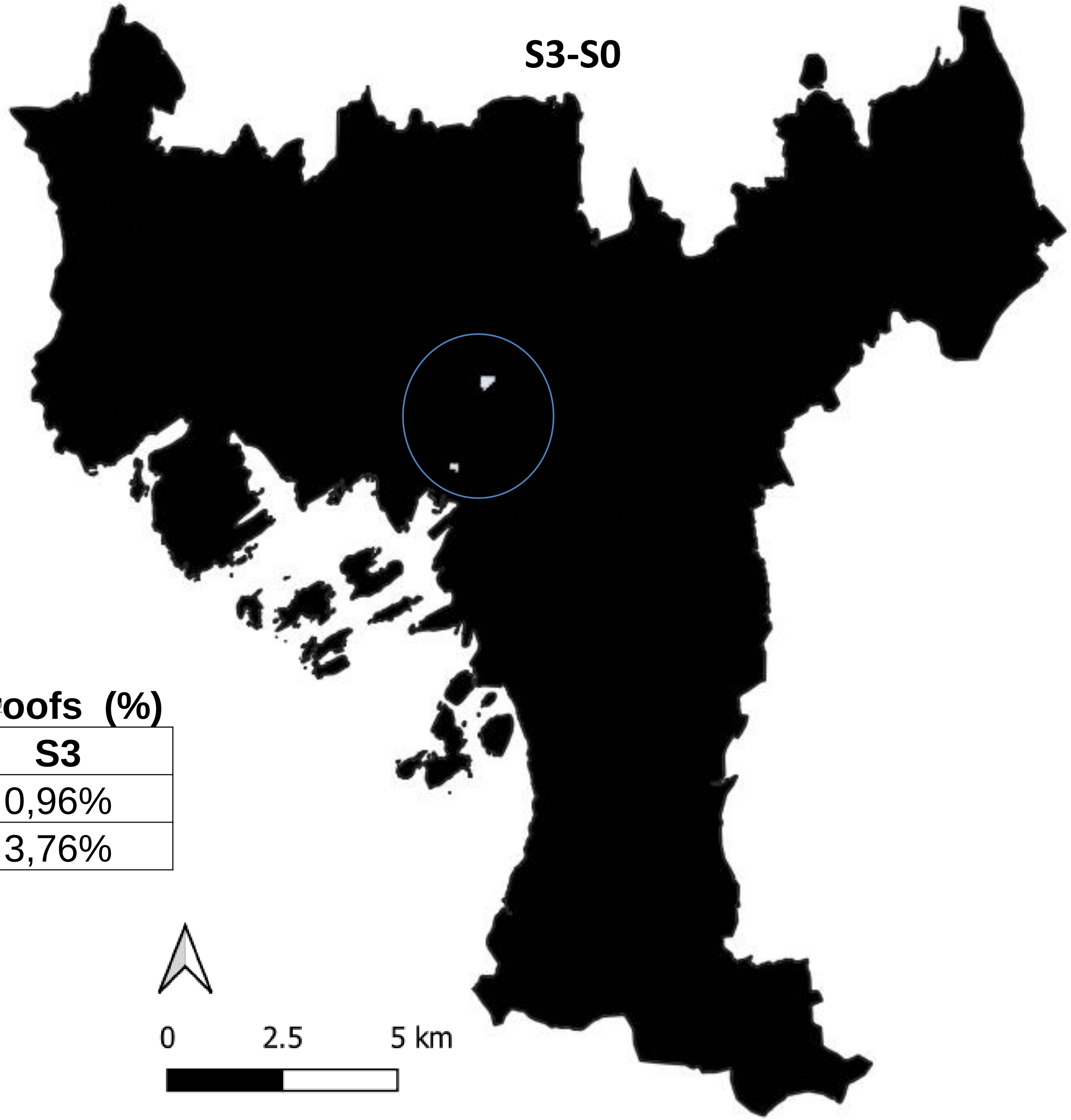
- Particulate matter (PM2.5 & PM10) (exposure)
- Children population density (sensitivity)
- Population density (sensitivity)

Local-scale vulnerabilities: results

Vulnerability to air pollution

Reduced vulnerability

No change in vulnerability



Annual air pollution reduction by green roofs (%)

	S0	S1	S2	S3
PM10	0,02%	0,03%	0,06%	0,96%
PM2.5	0,06%	0,14%	0,24%	3,76%

Indicators considered

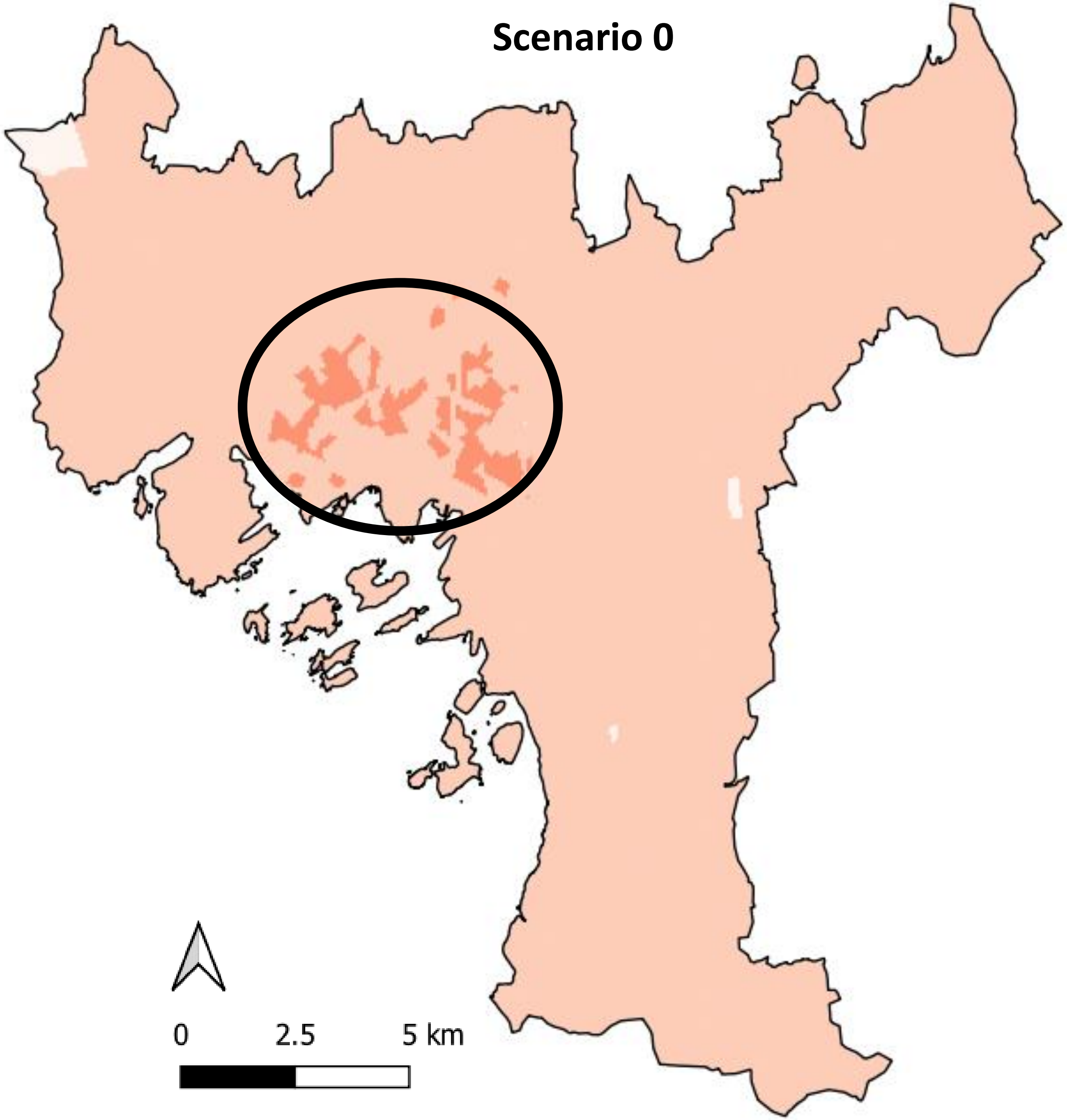
- Particulate matter (PM2.5 & PM10) (exposure)
- Children population density (sensitivity)
- Population density (sensitivity)

Local-scale vulnerabilities: results

Vulnerability to heat

No vulnerability

High vulnerability



Indicators considered

- Midday temperatures during heatwave (2018) (Exposure)
- Night temperatures during heatwave (2018) (Exposure)
- Elderly population density (Sensitivity)
- Population density (Sensitivity)
- Low-income households (Sensitivity)

Local-scale vulnerabilities: results

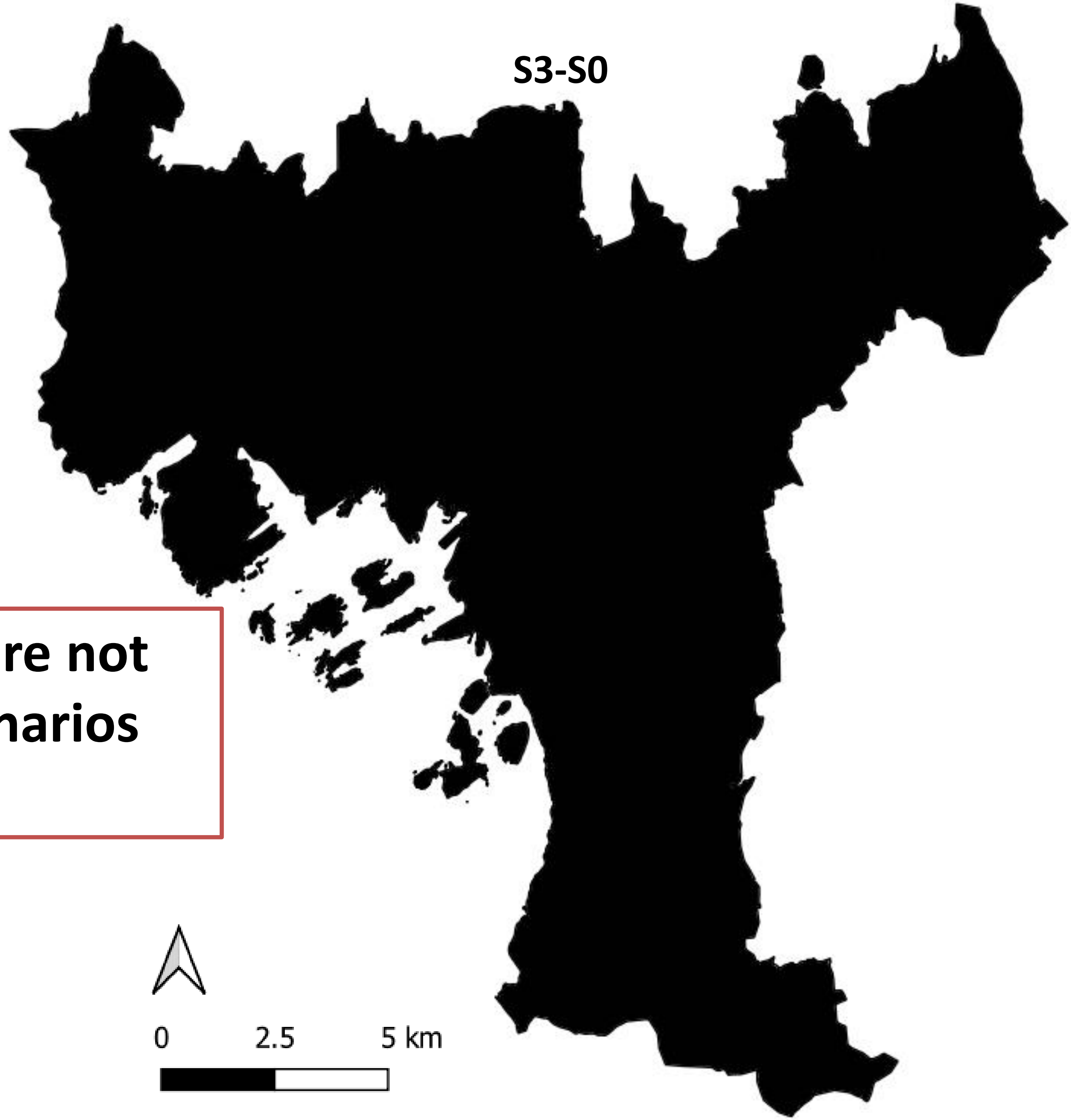
Vulnerability to heat

- Reduced vulnerability
- No change in vulnerability

Both night and day temperatures were not affected by green roofs in all the scenarios

Indicators considered

- Midday temperatures during heatwave (2018) (Exposure)
- Night temperatures during heatwave (2018) (Exposure)
- Elderly population density (Sensitivity)
- Population density (Sensitivity)
- Low-income households (Sensitivity)

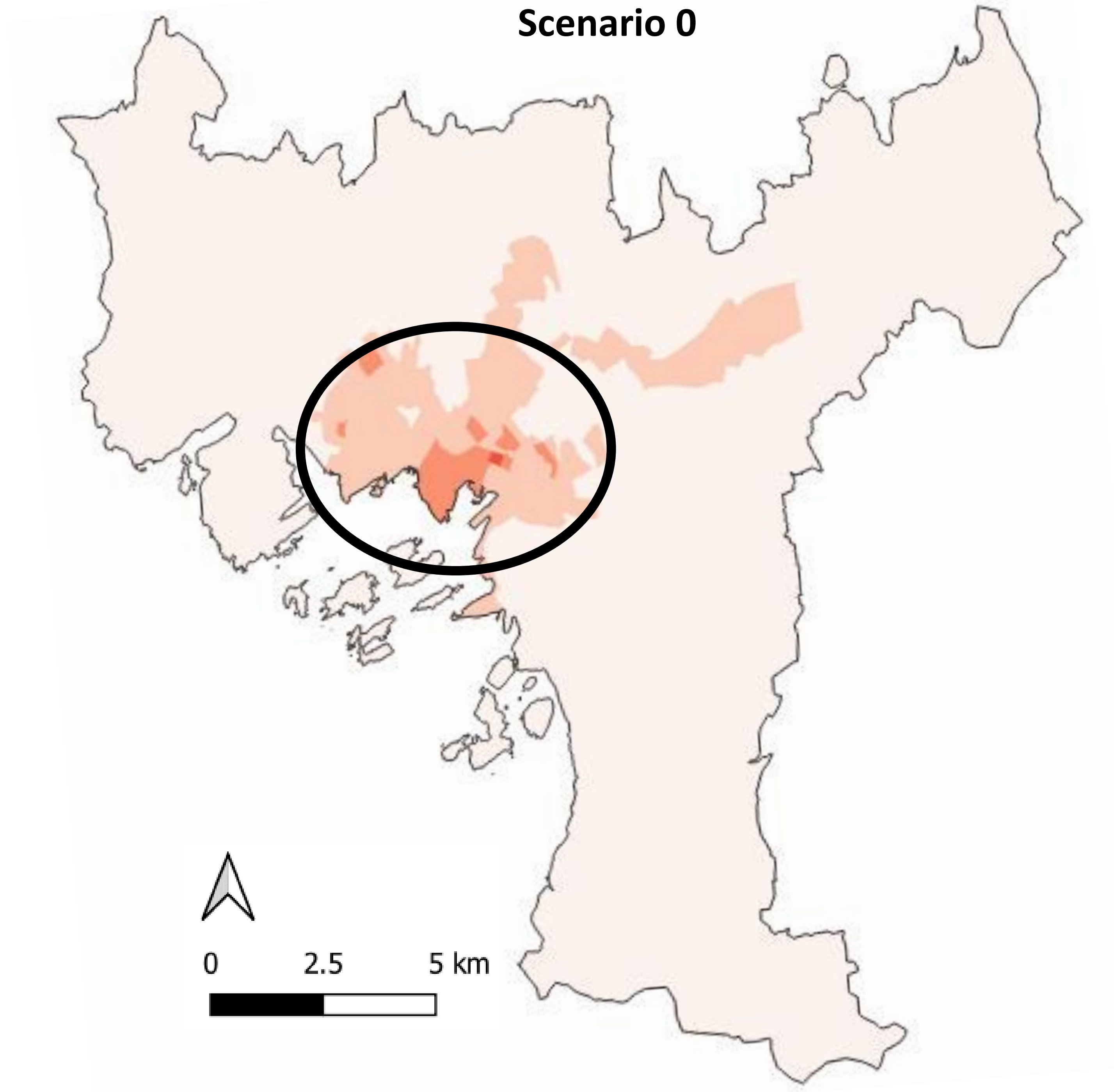


Local-scale vulnerabilities: results

Vulnerability to lack of opportunities for interacting with natural environments

No vulnerability

High vulnerability



Indicators considered

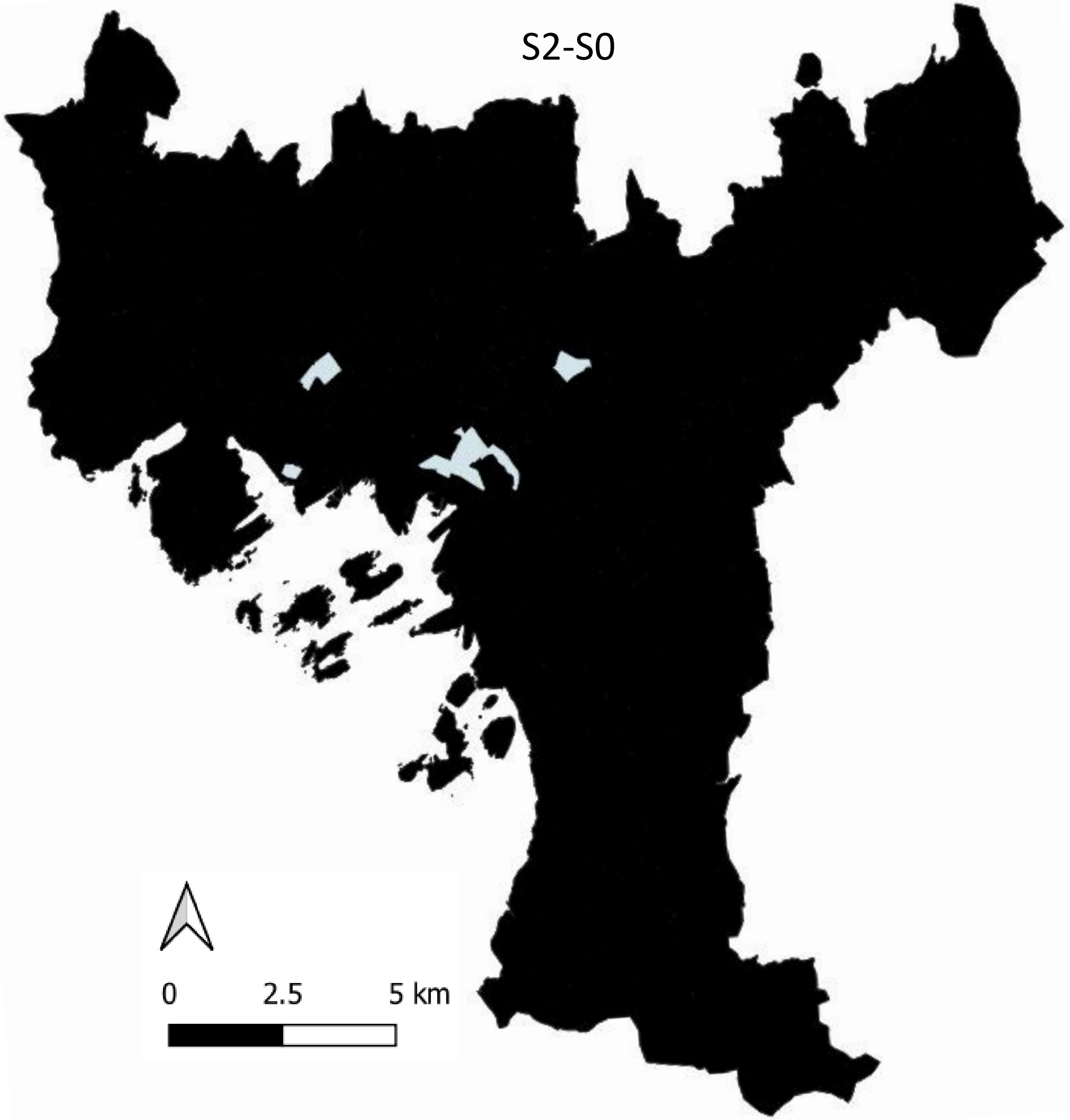
- Green cover (grunnkrets level) (Exposure)
- Green Gini coefficient (Delbydeler level) (Exposure)
- Population density (Sensitivity)
- Children population density (Sensitivity)
- Low-income households (Sensitivity)

Local-scale vulnerabilities: results

Vulnerability to lack of opportunities for interacting with natural environments

Reduced vulnerability

No change in vulnerability



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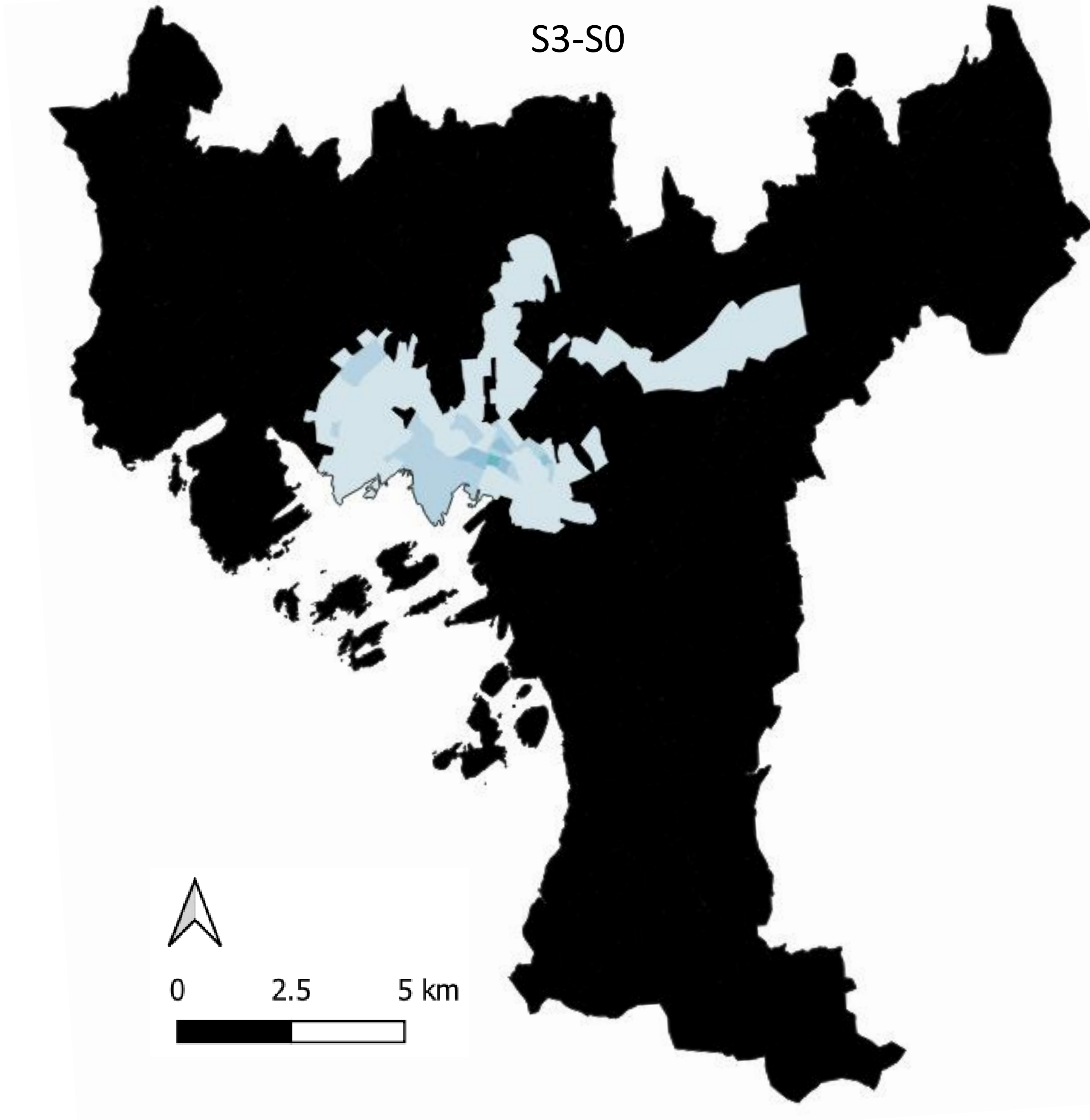
Local-scale vulnerabilities: results

Vulnerability to lack of opportunities for interacting with natural environments

Reduced vulnerability

No change in vulnerability



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- Population density (Sensitivity)
- Children population density (Sensitivity)
- Low-income households (Sensitivity)

Results

Broad-scale vulnerabilities

Broad-scale vulnerabilities

Vulnerability	Impact category	Unit	S1	S2	S3
To climate change	Global warming (GWP100a)	kg CO_2 eq	2.69E+05	6.42E+05	1.21E+07
To stratospheric ozone depletion	Ozone layer depletion (ODP)	kg CFC-11 eq	4.56E-01	1.09E+00	2.06E+01
To chemical pollution	Human toxicity	kg 1.4-DB eq	5.82E+06	1.39E+07	2.63E+08
	Fresh water aquatic ecotoxicity	kg 1.4-DB eq	5.98E+05	1.43E+06	2.70E+07
	Terrestrial ecotoxicity	kg 1.4- DB eq	9.69E+03	2.32E+04	4.38E+05
	Photochemical oxidation	kg C_2H_4 eq	8.09E+02	1.93E+03	3.66E+04
To changes in biogeochemical flows	Acidification	kg SO_2 eq	1.82E+04	4.35E+04	8.23E+05
	Eutrophication	kg PO_4 eq	5.93E+03	1.42E+04	2.68E+05

Life-cycle assessment (LCA)
Production: extraction of raw materials and manufacturing
Installation: machinery involved
Maintenance: fertilization
End-of-life: deconstruction and waste treatment
Functional unit: 1m^2 of extensive green roof with a lifetime of 40 years

Number of Norwegian houses producing the same impact on vulnerabilities *

	S1		S2		S3	
Vulnerability	**New green roofs**	**Houses**	**New green roofs**	**Houses**	**New green roofs**	**Houses**
To climate change	1,102	1	2,622	2	64,816	37
To stratospheric ozone depletion	1,102	10	2,622	23	64,816	435
To chemical pollution	1,102	64	2,622	153	64,816	2,895
to changes in biogeochemical flows	1,102	16	2,622	37	64,816	705

*Based on comparison to single Norwegian residential wooden building of 200m2 over 50 years, covering construction, maintenance, operation, and end-of-life treatment based on calculations from Dahlstrøm et. al, 2012

Conclusions

Conclusions

1. Green roofs impact local-scale vulnerabilities unevenly

2. GR location plays a major role in tackling local-scale vulnerabilities
    - S3 showed the location of GR is more important than their quantity
    - S1 and S2 show that following the spatial pattern of GR from 2017 is not effective in providing the greatest reduction in vulnerabilities

3. The quantity of GR implemented does have impacts on the Broad-scale vulnerabilities, so their implementation must be efficient

4. The strategic location of new green roofs can greatly reduce some local-vulnerabilities while minimizing the undesired impacts on broad-scale vulnerabilities.

Participatory exercise 1: instructions

1 Group weighting of vulnerabilities

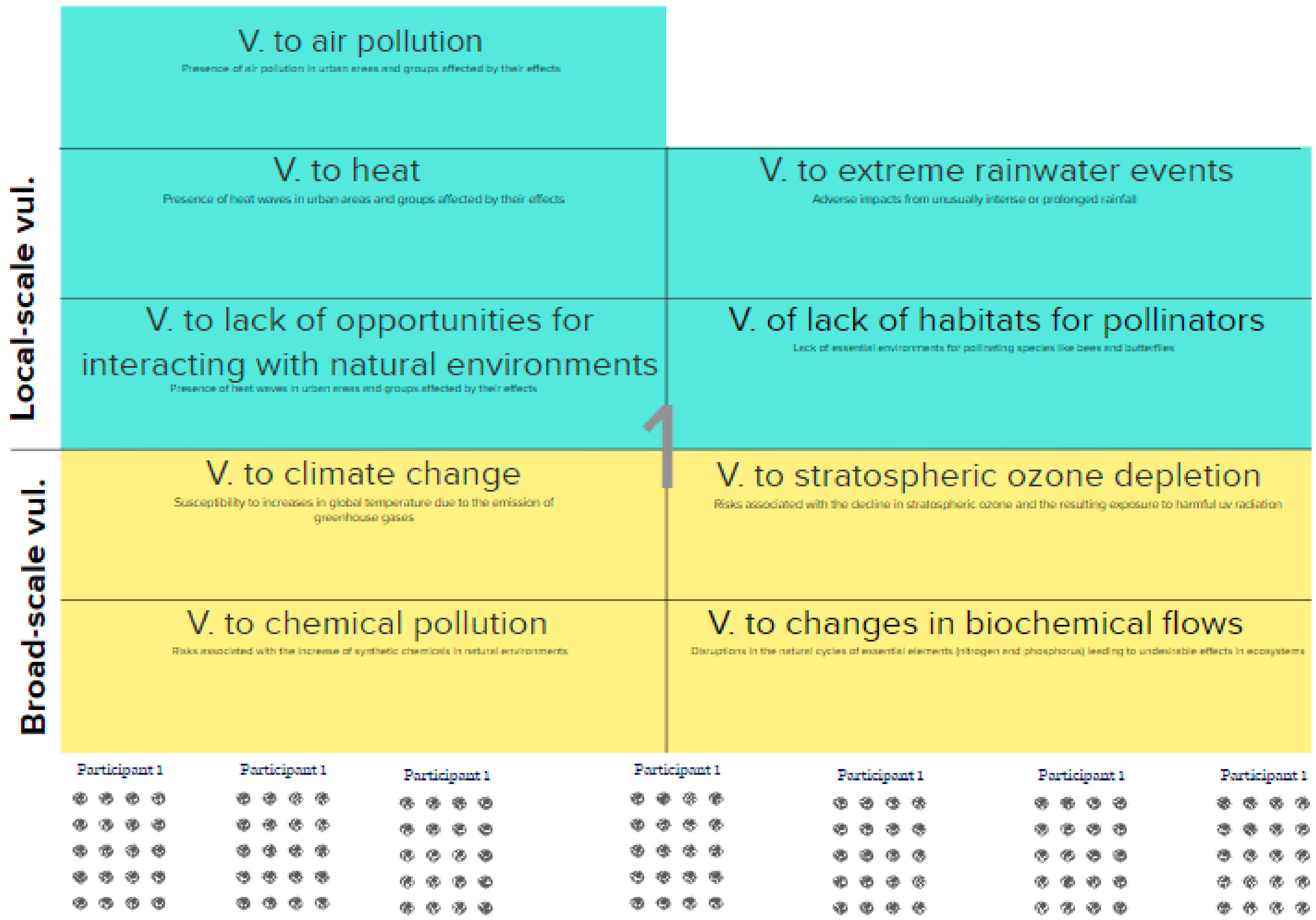
Objective: To discuss and negotiate which vulnerabilities you consider more or less relevant according to your professional criteria.

Instructions: Each group will have their own MURAL board where they will find a list of vulnerabilities to be ranked by importance, following the steps below:

1. Step 1: Each participant will have to say out loud which vulnerability they consider to be the most important, and why. Then, the participant will place 1 pebble in the diagram on that vulnerability. Keep in mind that no double mentions are allowed, until saturation.
2. Step 2: Next, each participant allocates the rest of their pebbles among the vulnerabilities based on their professional background (this needs to be done individually and finished as soon as possible).
3. Step 3: Then, the group collectively rearranges the weights of the vulnerabilities by reaching consensus on the relative importance of each of the vulnerabilities.

This is your first group challenge!

Participatory exercise 1: weighting diagram



Participatory exercise 2: instructions

2 Relevance for policy making

Could any policy measures or strategies be implemented based on the green roofs' impacts presented today?

1) Individually add post-its with possible policies. One policy idea in each post-it.(take about 5 minutes).
2) When everyone has finished, collectively rearrage policies based on patterns that you see/notice. Yes, it will be messy!! But try rearranging and observe how other colleagues are also rearranges and see if you can add anything
3) Once done we will turn on the mics and share aloud you observations

Policy example

Regulation of land uses based on most vulnerable areas

Awarenes and relevance of research