

CLEANING

THE

AIR

Mitigating air pollution
through Urban Design

P5 PRESENTATION

30th June 2017

C O N T E N T S

01

the issue

02

scope, research question, methodology

03

theory and analysis

04

design interventions

05

conclusions



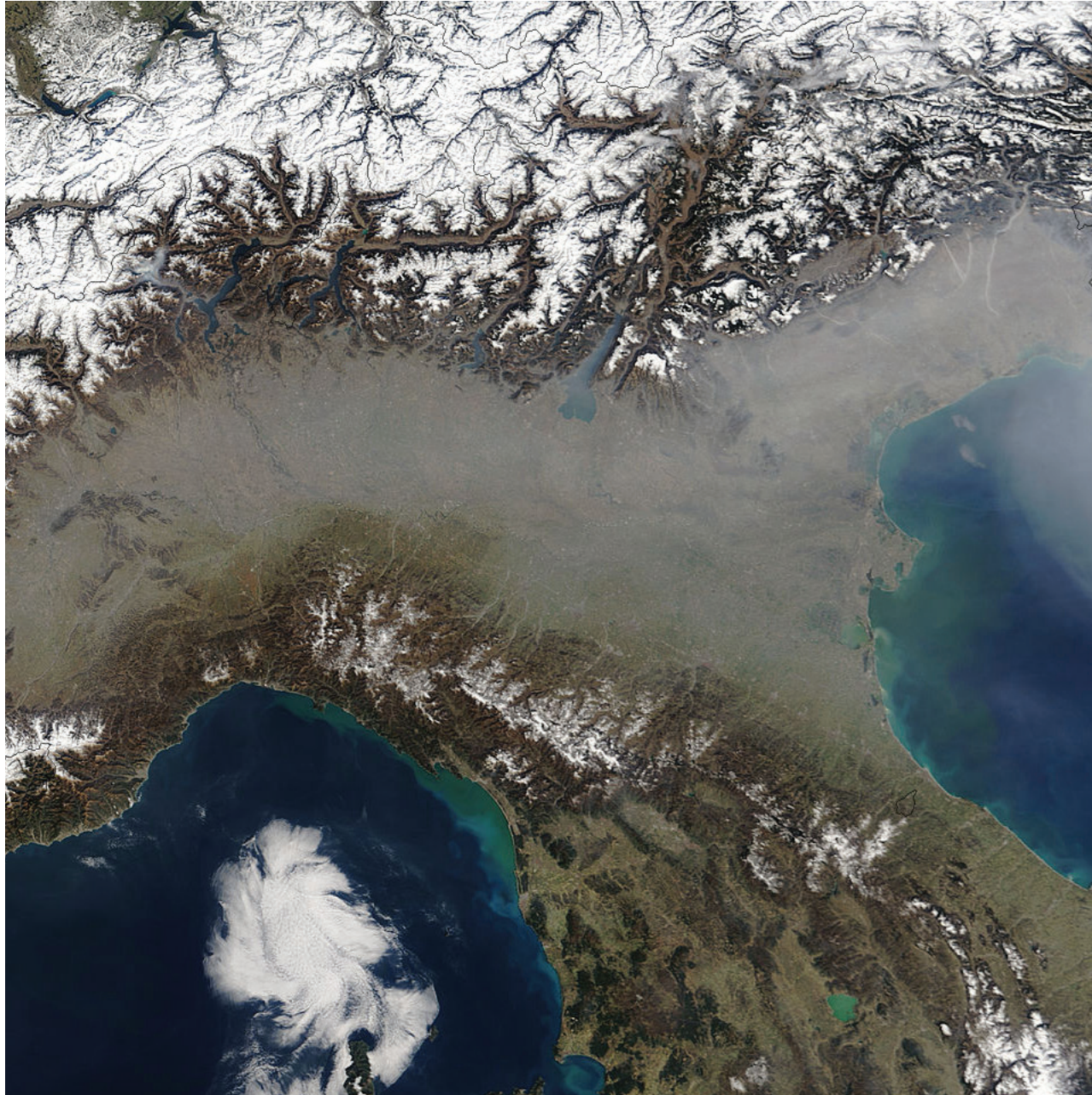
the issue





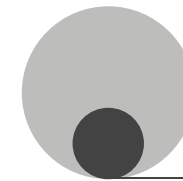
“Air pollution poses the largest **environmental health risk** in Europe today”

European Environment Agency, 2015



source: <http://legambientept.altervista.org/2013/06/02/autostrada-valdastico-nor>

Italy has the **highest** rate of **death related** to air pollution in **Europe**



almost 20 %
of deaths
in Italy

European Environment Agency, 2015

source: http://www.ansa.it/piemonte/notizie/2017/02/19/smog-superato-limite-per-2017-a-torino_e66c8519-e043-4cf3-8183-

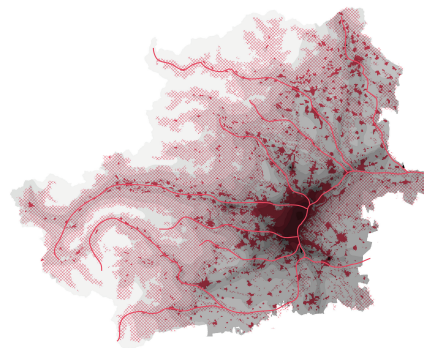
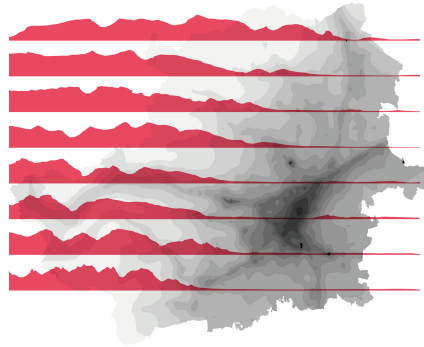
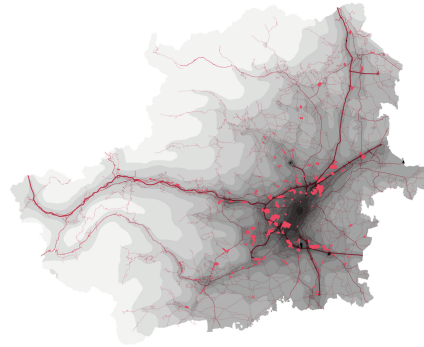


Turin is one of the **four most polluted cities in Italy**

Mal'Aria, 2016

NO₂ NITROGEN DIOXIDE LIMIT VALUE 40		
	city	ng/mc
1	Torino	52.3
2	Roma	49.1
3	Milano	47.7
4	Trieste	47.0

PM₁₀ PARTICULATE MATTER LIMIT VALUE 35		
	city	days
1	Frosinone	115
2	Pavia	114
3	Vicenza	110
4	Milano	101
5	Torino	99



Nitrogen Dioxide



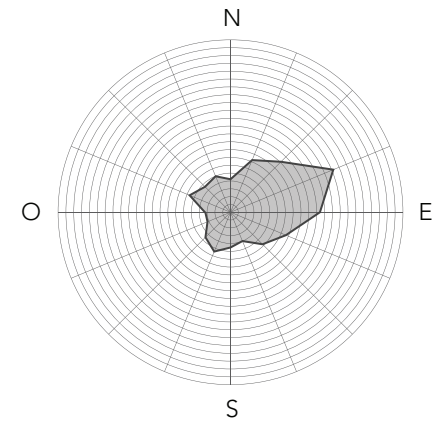
Particulate Matter 10



Particulate Matter 2.5



Average wind speed
2.06 m/s



Car sharing



Bike sharing



Speed control



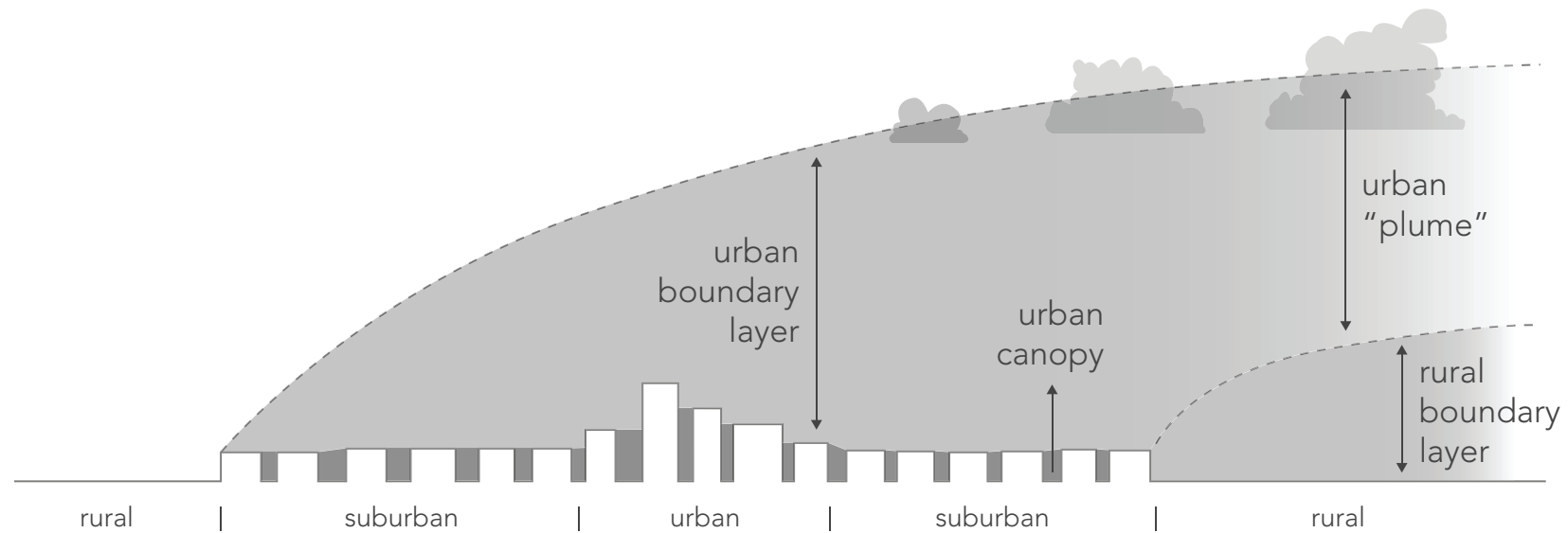
Public transportation





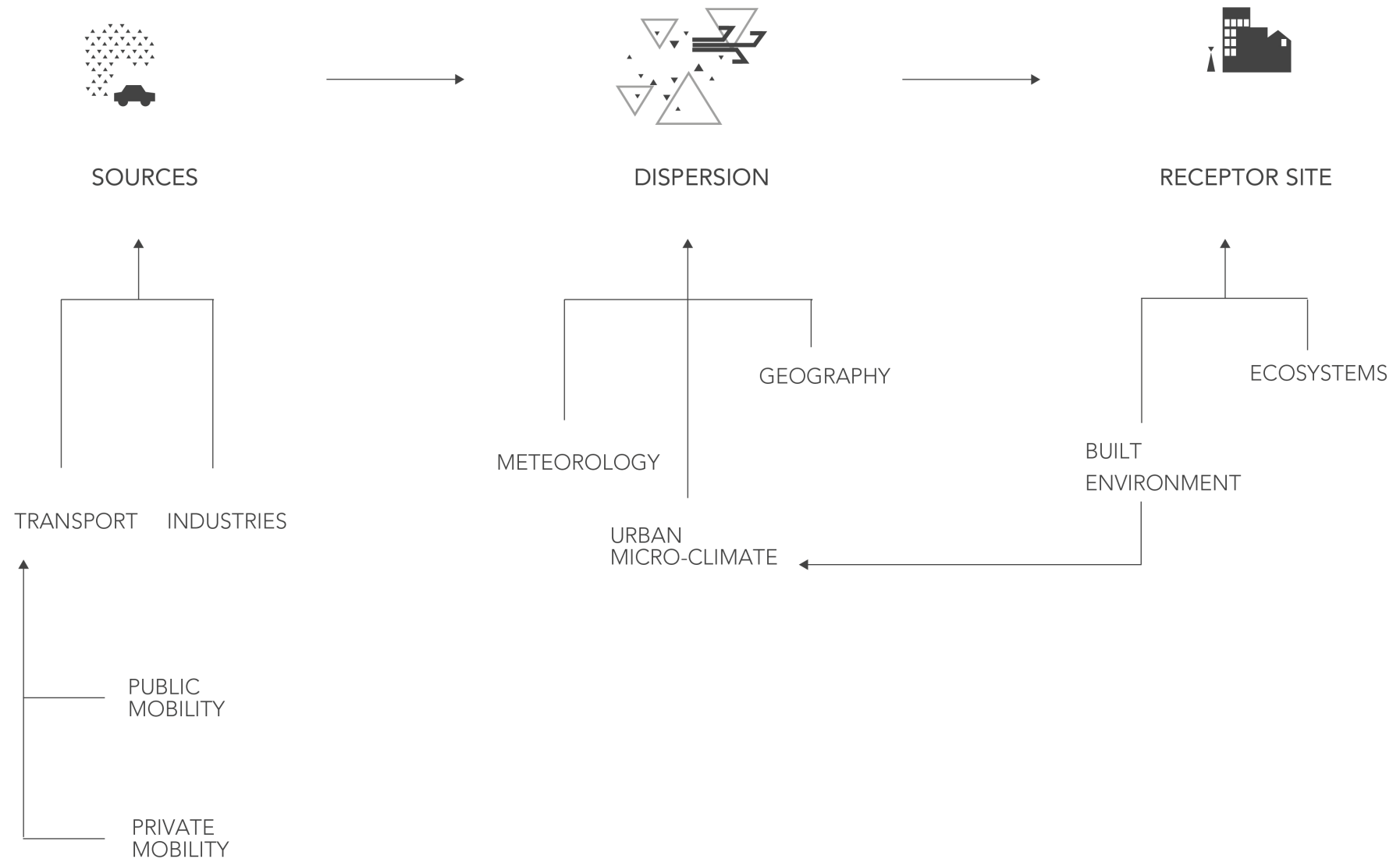
scope and
research
question

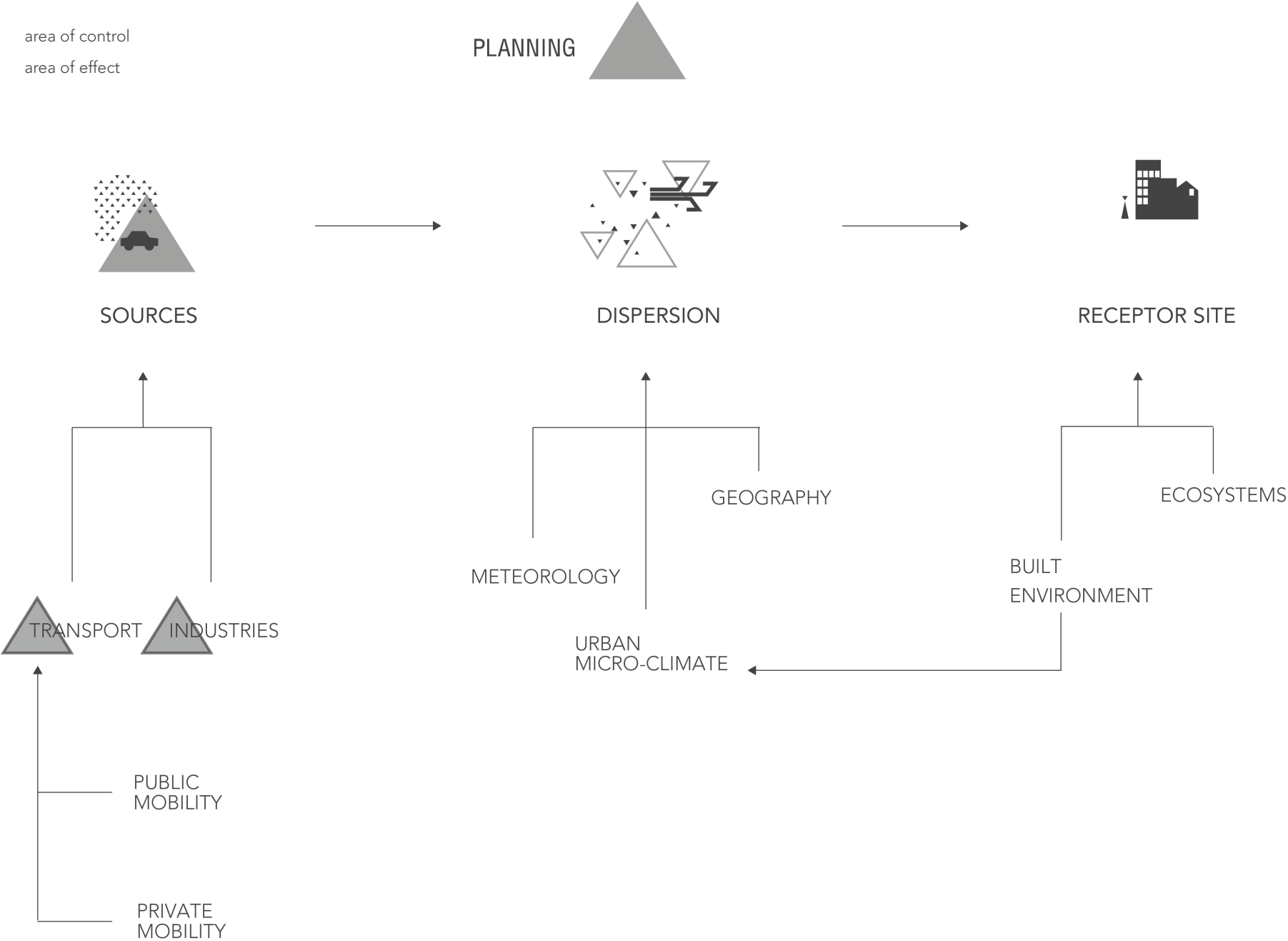
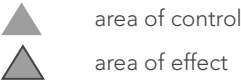
Scales of air pollution



sources: Oke, J. (1987). Boundary Layer Climate

Urban designer work with more than two extreme
scales, **intermediate scales** are needed.





 area of control
 area of effect

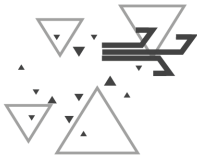
PLANNING



URBAN DESIGN



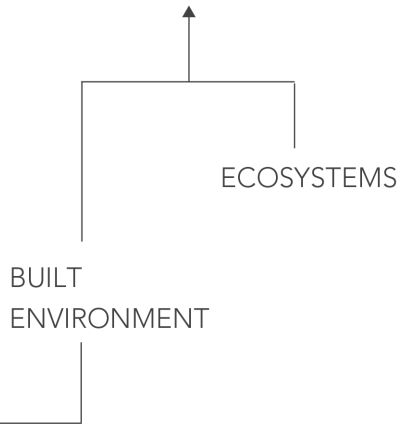
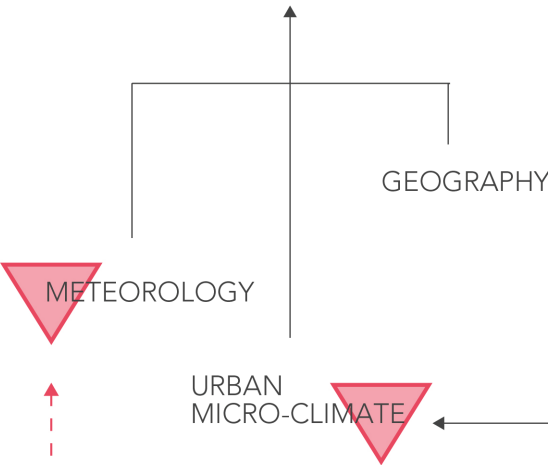
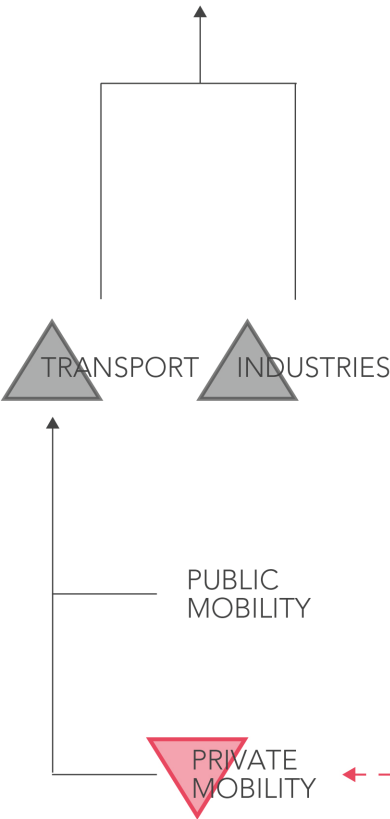
SOURCES

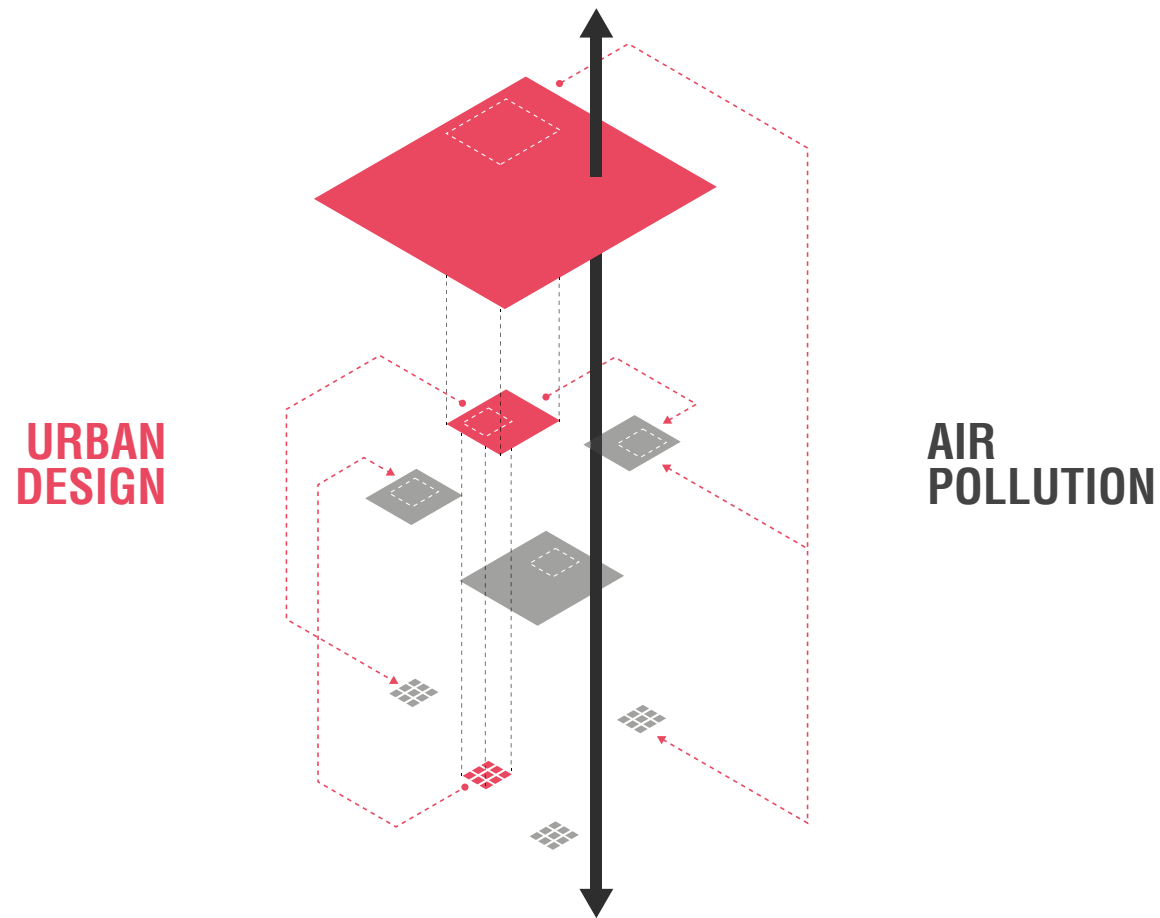


DISPERSION



RECEPTOR SITE





The aim is to understand the **relation** between **air pollution** and **the built environment** and developing an **interscalar approach**.



How can urban design mitigate air pollution in the city of Turin?



source: <http://www.bookingable.com/allotments/localita.html?d=7>

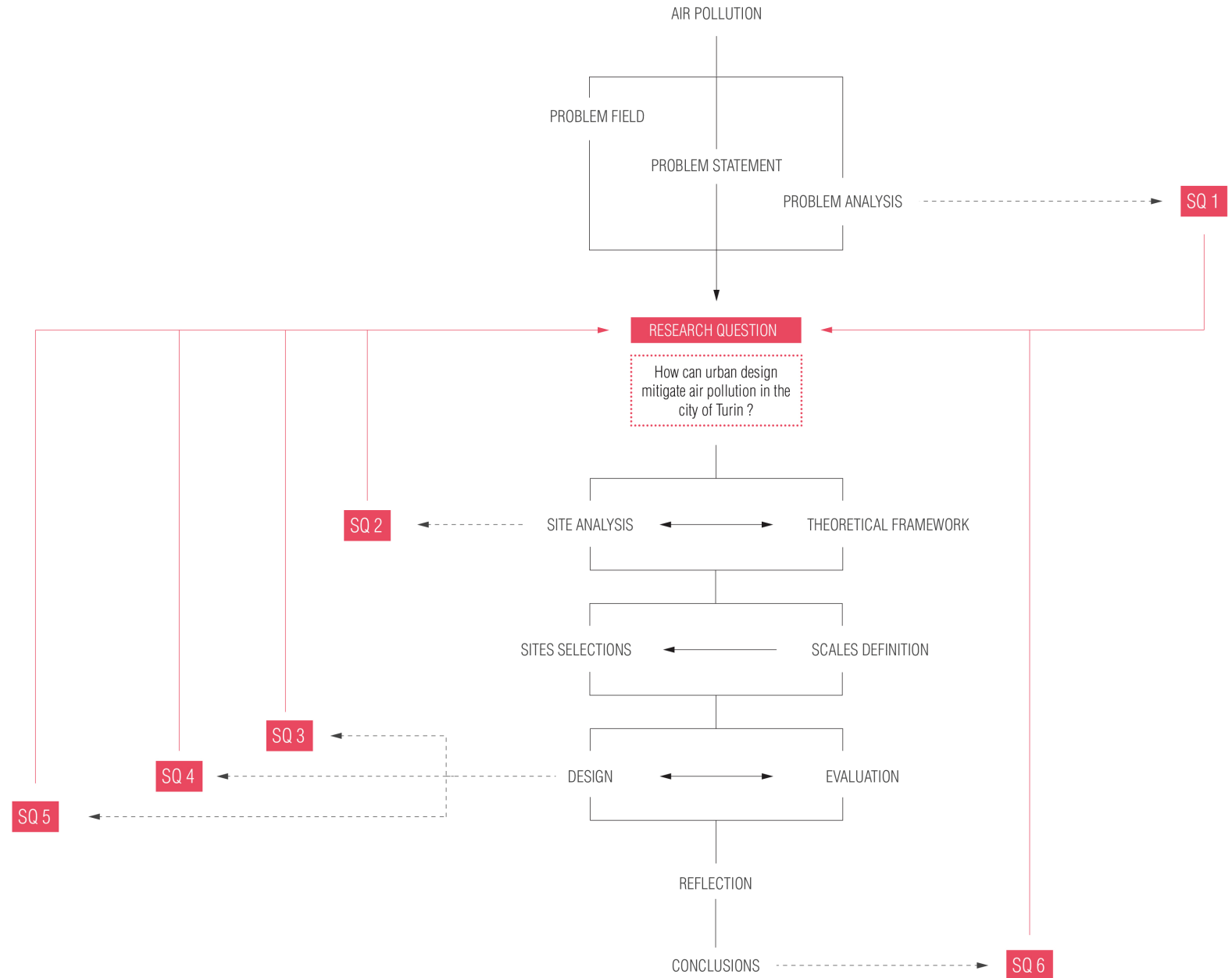
EXPLORATIVE

ANALYTICAL

DESIGN

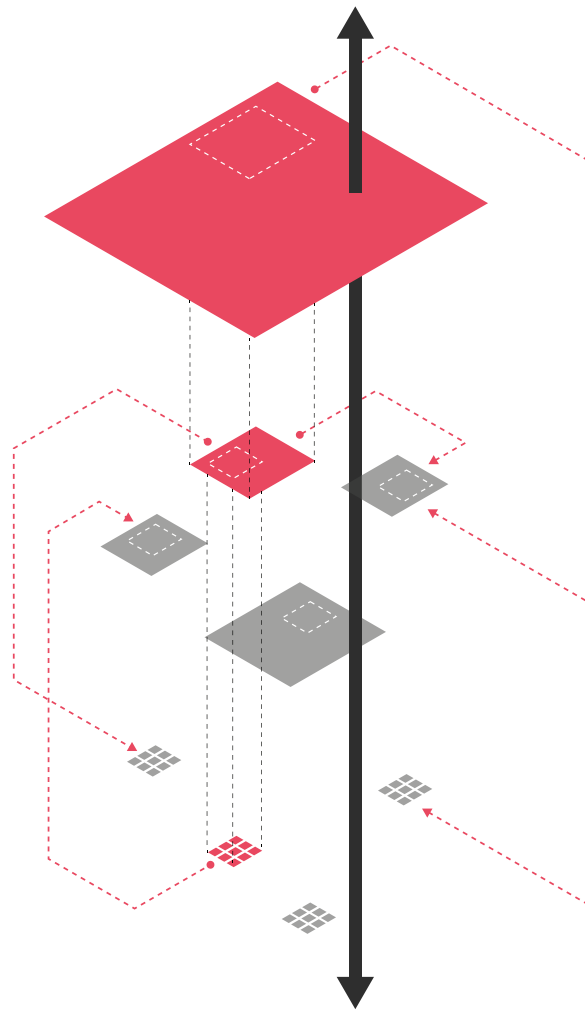
EMPIRICAL

REFLECTIVE





theory and
analysis

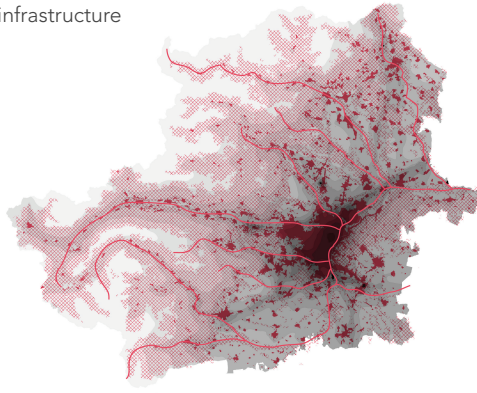


i d e n t i f y

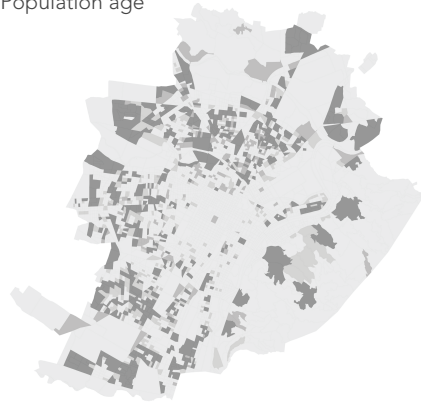
most vulnerable areas in Turin

scales of air pollution

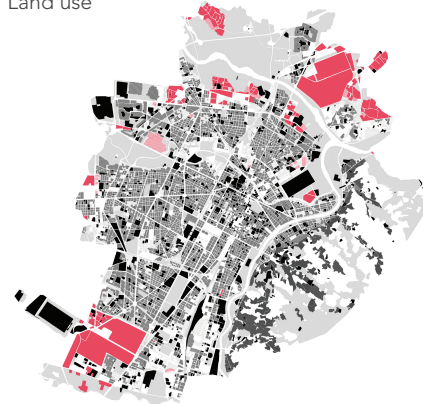
	Source	Dispersion	Receptor Site	Measurement Unit	Aggregation Unit	Workability	Impact Rate	Theoretical Framework
Mesoscale	L1 Pollutants			various (different for each pollutant)	municipality	▼▲▼▲▼	to be discovered	derived from problem statement
		L2	L2 Land Use + Built environment + Forests + Agricultural land	[-]	-	▼▲▼▲▼	to be discovered	Krautheim, M., Pasel, R., Pfeiffer, S and Schultz-Granberg, J. (2014). City and Wind. Climate as an Architectural Instrument. Dom Publisher, Berlin. Oke, T.R. (1987). Boundary layer climates. New York, Rutledge.
		Terrain L3	L3	[-]	-	▼▲▼▲▼	to be discovered	Oke, T.R. (1987). Boundary layer climates. New York, Rutledge.
	+		L4 Land Use + Residential + Touristic + Commercial + Mixed Use + Production + Industrial + Green Areas + Services	[-]	-	▼▲▼▲▼	to be discovered	Meurs, H., van Wee, B. (2003). Land Use and Mobility: a Synthesis of Findings and Policy Implications. EJTIR, 2, 219-233 De Vos, J. (2015). The influence of land use and mobility policy on travel behavior: A comparative case study of Flanders and the Netherlands. The Journal of transport and land use, 1, 171-190 Meurs, M. (2003). Special issue: Land Use and Sustainable Mobility. EJTIR, 3, no. 2, 109-117 Oke, T.R. (1987). Boundary layer climates. New York, Rutledge. Erell, E., Pearlmutter, D. & Williamson, T.
Urban Canopy	L5 Traffic			Intensity (average number)	neighborhood subunit	▼▲▼▲▼	to be discovered	derived from problem analysis
		Vegetation L6	L6	[-]	-	▼▲▼▲▼	to be discovered	Vos, P., Maiheu, B., Vankerkom, J., JanssenImproving, S. (2013). Local air quality in cities: To tree or not to tree? Environmental Pollution, 183, 113-122
		L7 Wind + Direction + Speed		meters [m] angles [degree]	-	▼▲▼▲▼	to be discovered	Erell, E., Pearlmutter, D. & Williamson, T. (2011). Urban Microclimate: Designing the Spaces between Buildings. Earthscan, London. Oke, T.R. (1987). Boundary layer climates. New York, Rutledge.
		L8 Roughness		meters [m]	buildings	▼▲▼▲▼	to be discovered	Krautheim, M., Pasel, R., Pfeiffer, S and Schultz-Granberg, J. (2014). City and Wind. Climate as an Architectural Instrument. Dom Publisher, Berlin. Oke, T.R. (1987). Boundary layer climates. New York, Rutledge.
		L9 Density + FSI + GSI		qm/qm	building - block	▼▲▼▲▼	to be discovered	Pont, P., Haupt, P. (2010). Space Matrix: Space, Density and Urban Form. Met Boyko, C., Cooper, R. (2011). Clarifying and re-conceptualising density. Progress in Planning, 76, 1-61
	L10		L10 Population + Density + Age	Inhabitants for squared kilometer [inh/skm]	neighborhood - neighborhood subunit	▼▲▼▲▼	to be discovered	Hilber, C. (2014) Urban Development and Air Pollution: Evidence from a Global Panel of Cities Alexis, N., Barnes, C., Bernstein, L., Bernstein, J. A., Nel, A., Peden, D., Brock Williams, P. (2004). Health effects of air

Green and blue
infrastructure

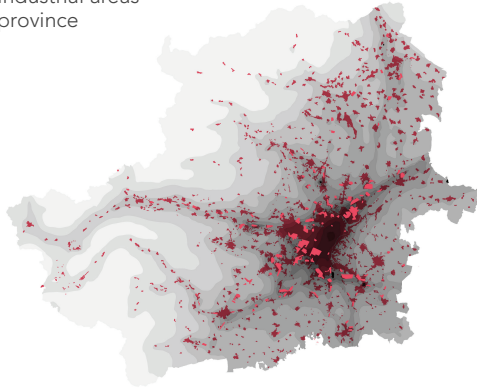
Population age



Land use



FSI

Industrial areas -
province

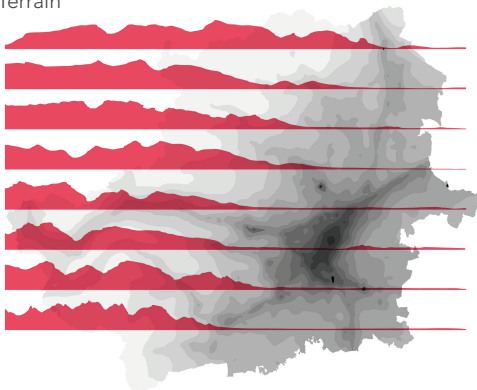
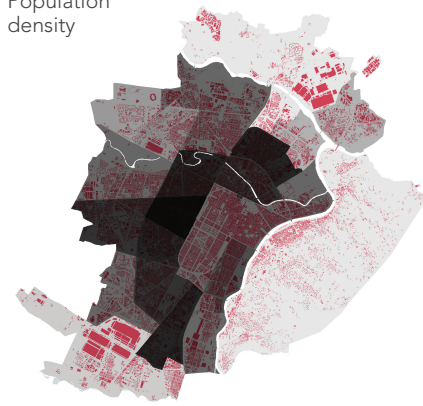
Roughness



GSI

Urban
vegetation

Terrain

Terrain -
municipalityPopulation
density

Traffic



risk-hazard approach

vulnerability x hazard



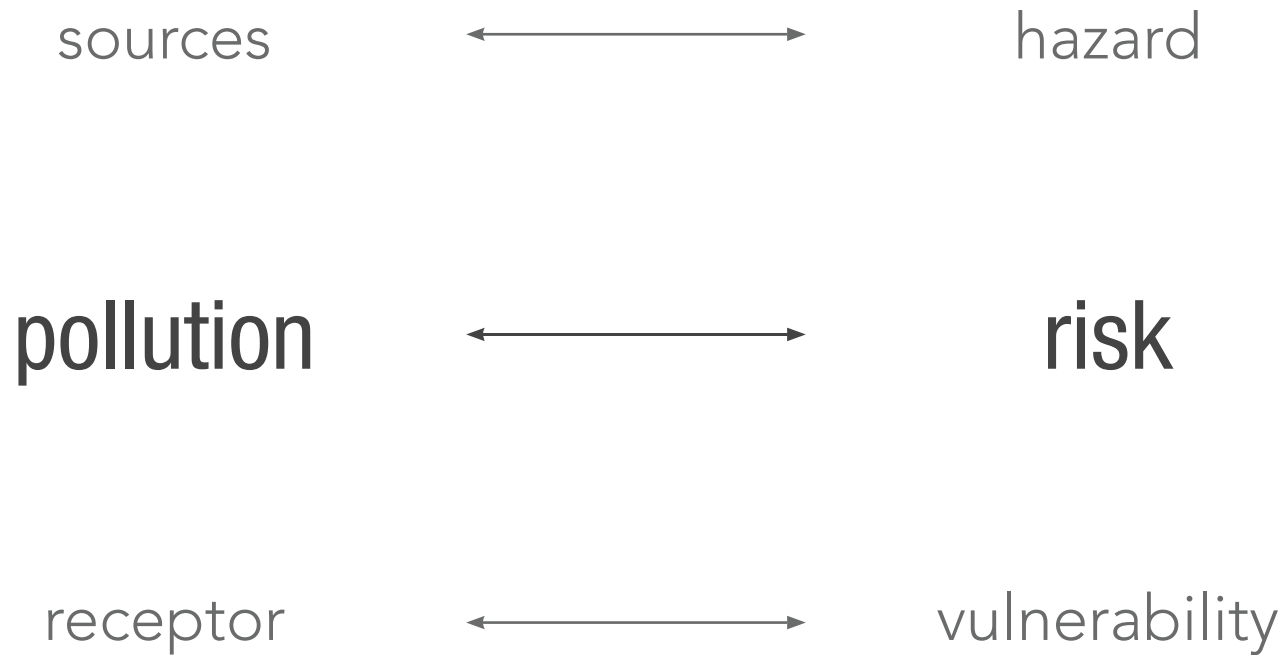
an inherent property of a system arising
from its internal characteristics

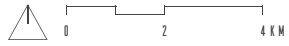
(Adger, 1999; Adger and Kelly, 1999).



potentially damaging physical event

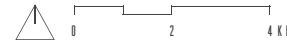
(UN, 2004)





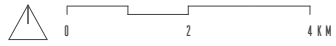
Hazard

- highly congested roads
- congested roads
- areas with the highest rate of cars
- areas with high rate of cars



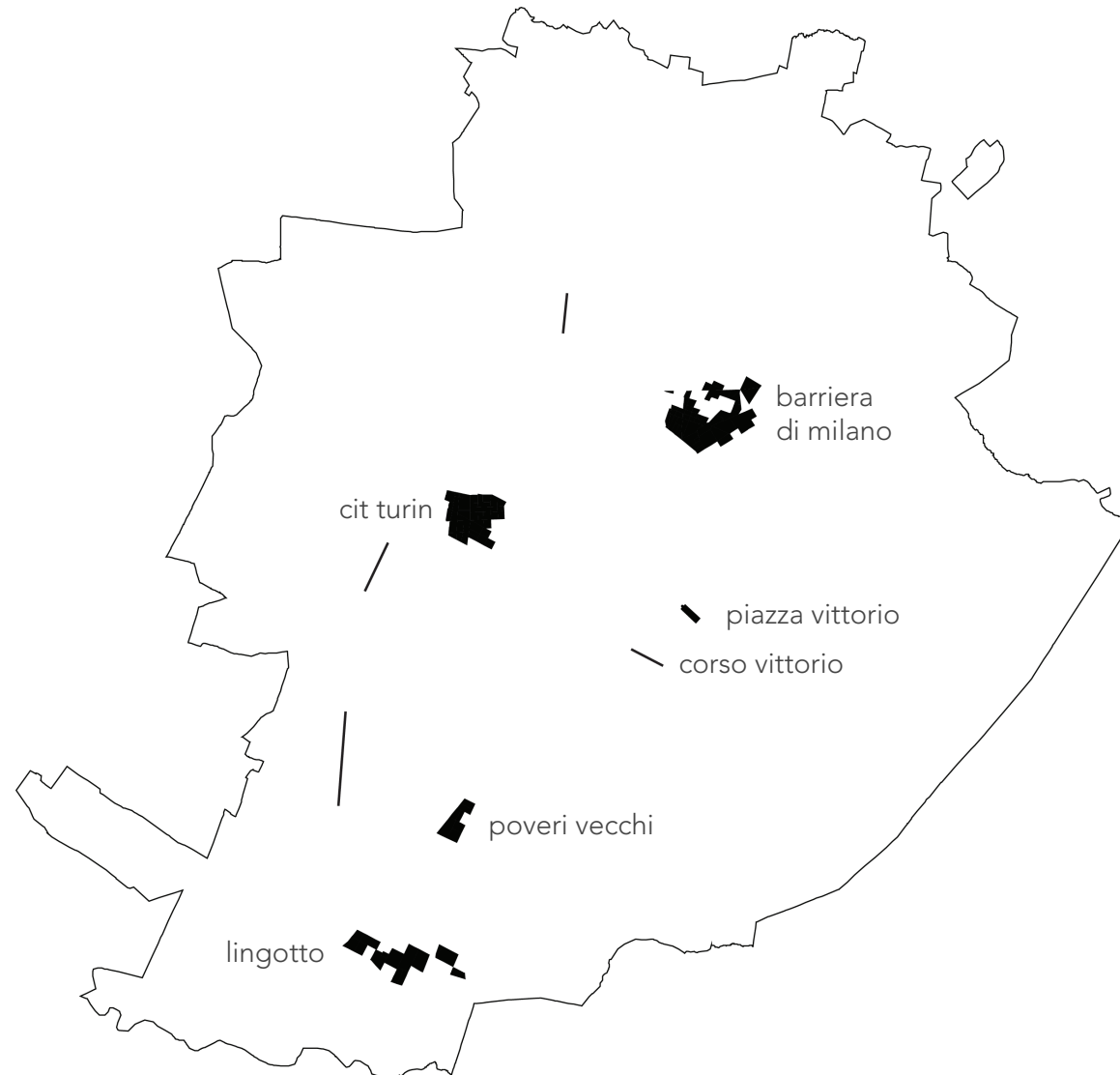
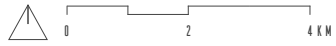
Vulnerability

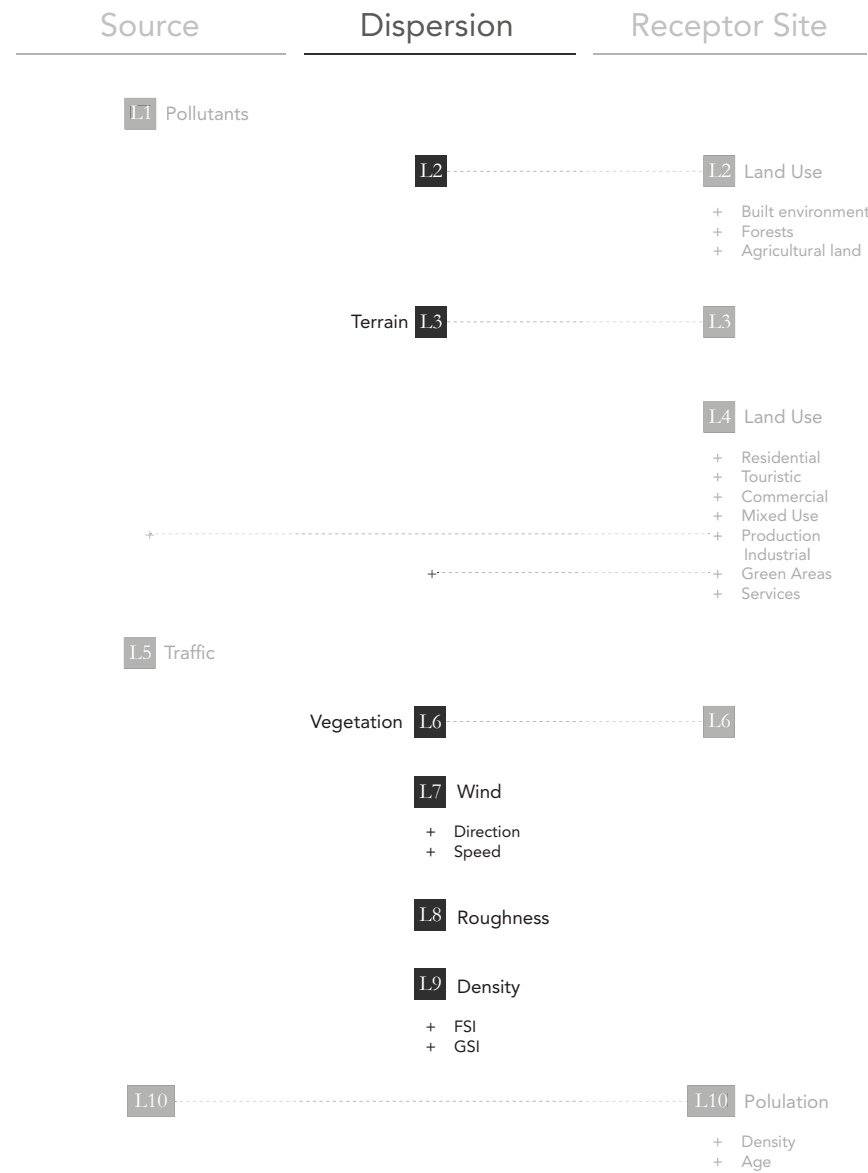
- people under 14 and above 60 y.o. > 60 %
- people under 14 and above 60 y.o. 50 - 30 %
- people under 14 and above 60 y.o. < 30 %
- healthcare and education infrastructure



Risk

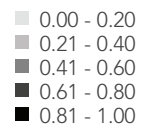
- very high
- high
- medium
- low
- very low



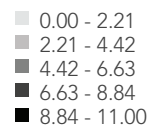


Urban
fabric

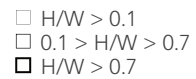
GSI



FSI



Roughness



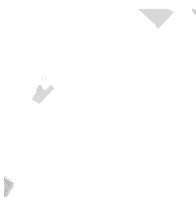
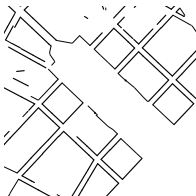
Land use



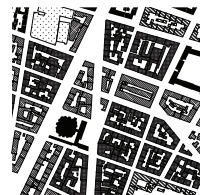
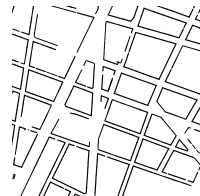
Vegetation



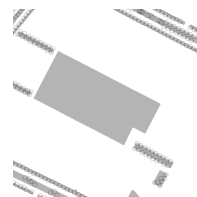
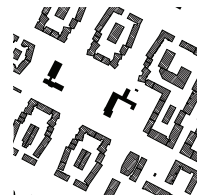
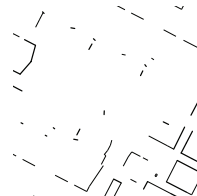
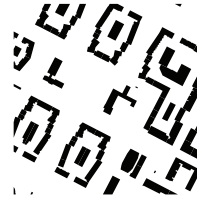
piazza vittorio



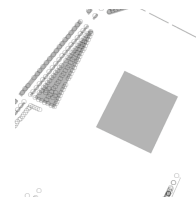
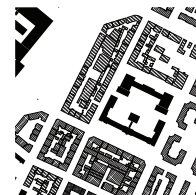
barriera di milano



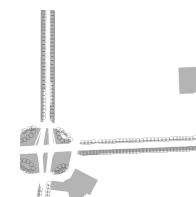
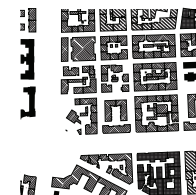
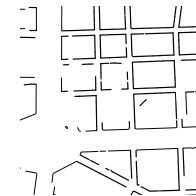
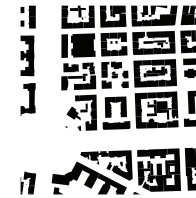
lingotto



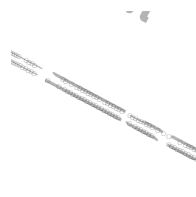
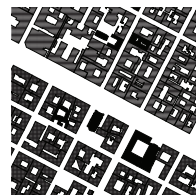
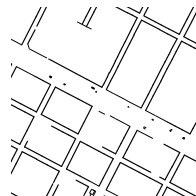
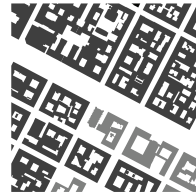
poveri vecchi



cit turin

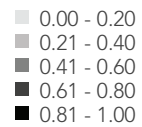


corso vittorio

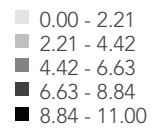


Urban
fabric

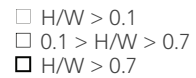
GSI



FSI



Roughness



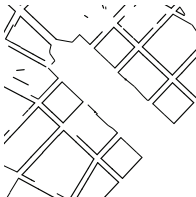
Land use



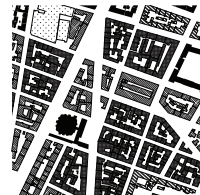
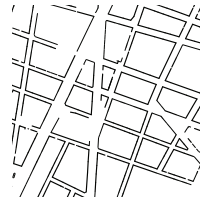
Vegetation



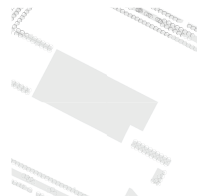
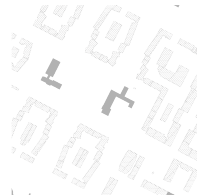
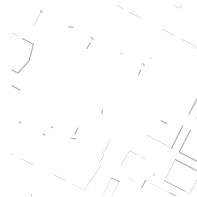
piazza vittorio



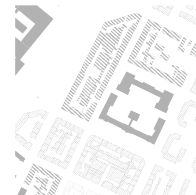
barriera di milano



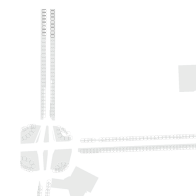
lingotto



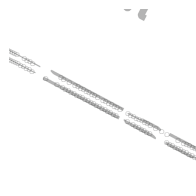
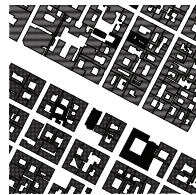
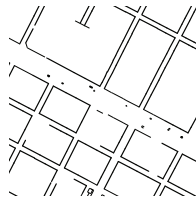
poveri vecchi

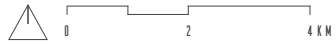


cit turin



corso vittorio







d e s i g n
i n t e r v e n t i o n s

design approach

- + social and climate analysis
- + design proposal
- + evaluation
- + implementation



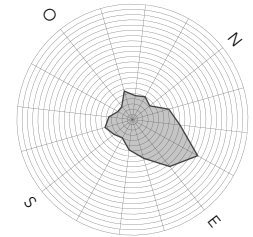
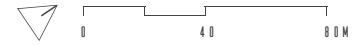
piazza vittorio



source: author

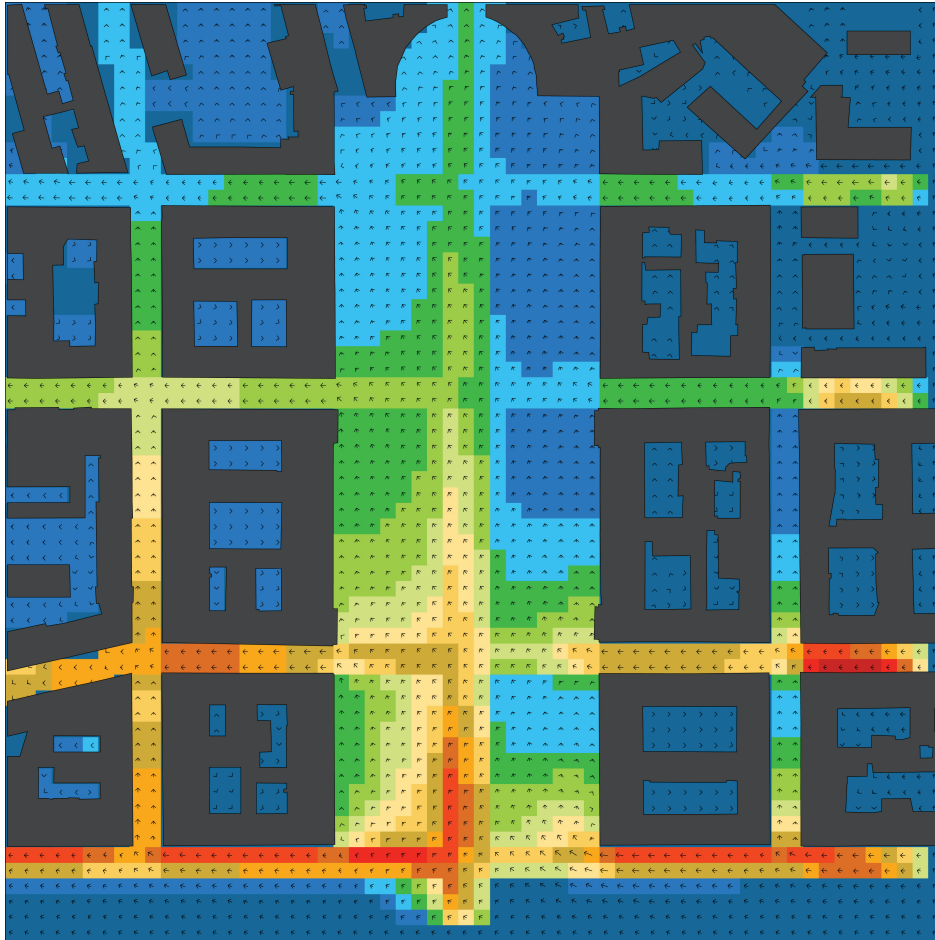
source: frame derived from <https://www.youtube.com/watch?v=hIAk7dNQ7uE>

source: author

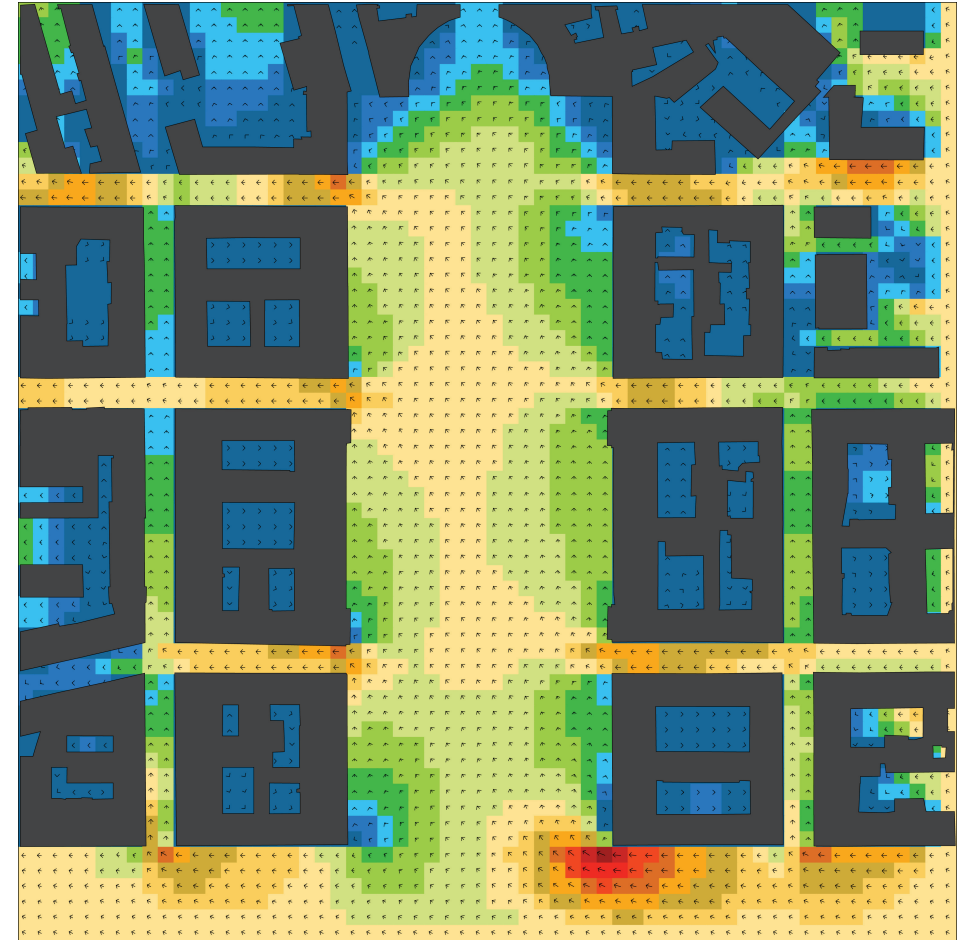
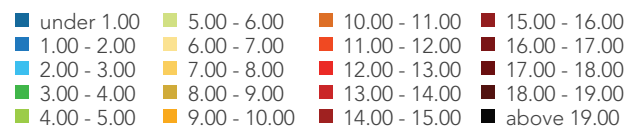


Uses

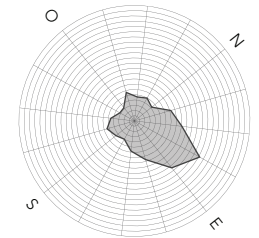
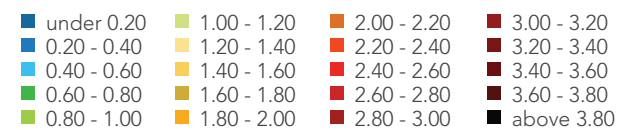




PM10 Concentration [mcg/m3]



Wind Speed [m/s]



source: <http://greencitysolutions.de/english/#citytree>



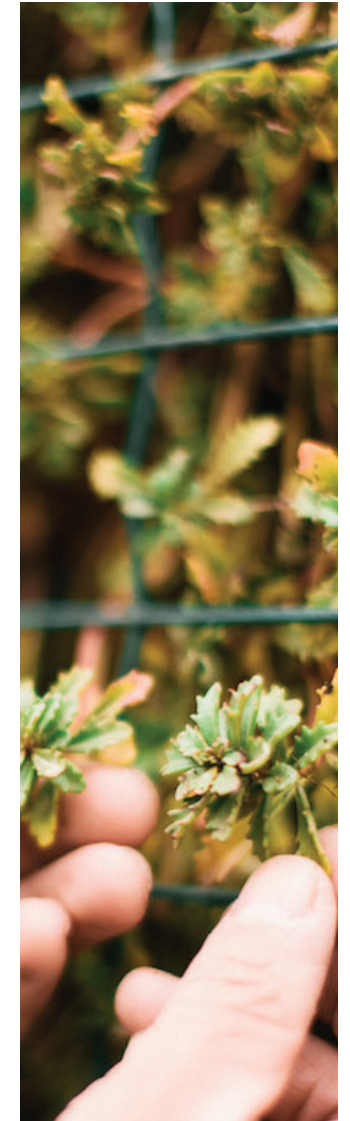
source: <https://letitgrow.org/combining-economy-and-ecology-to-battle-urban-air-pollution/>



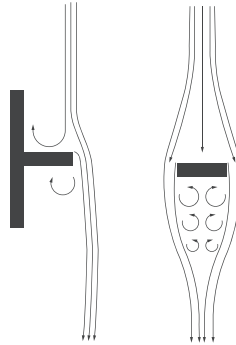
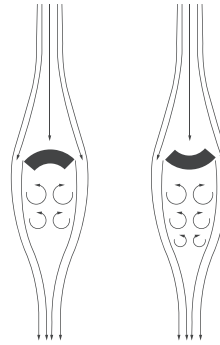
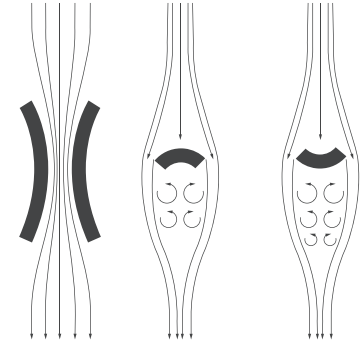
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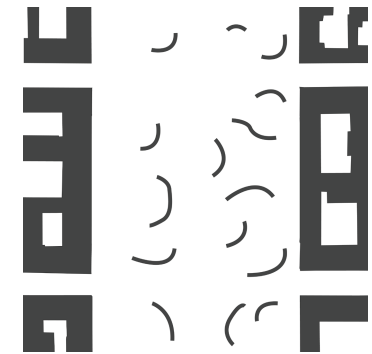
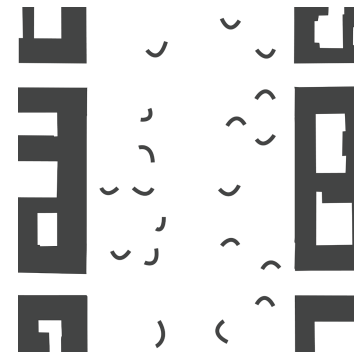
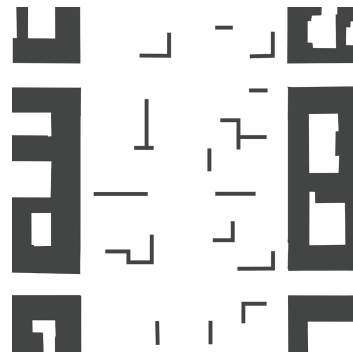
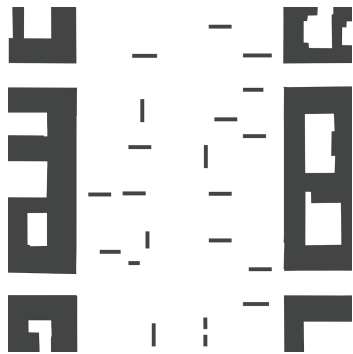
source: <http://greencitysolutions.de/english/#citytree>



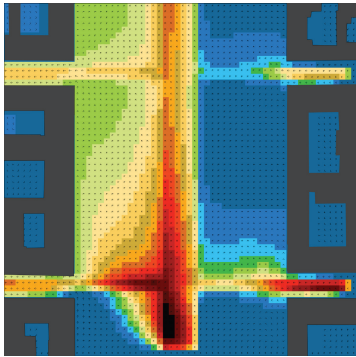


wind flows
behaviors studieslinear and scatteredlinear and continuouscurvy and scatteredcurvy and continuous

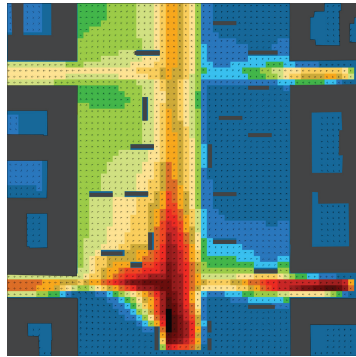
conceptual maps



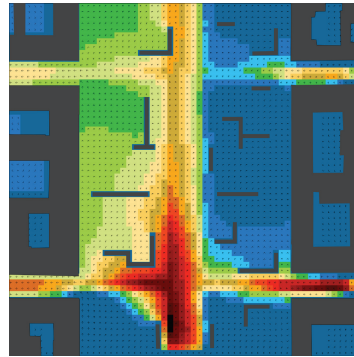
current



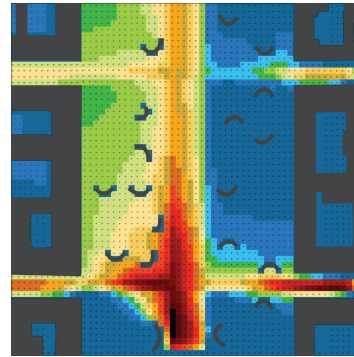
linear and scattered



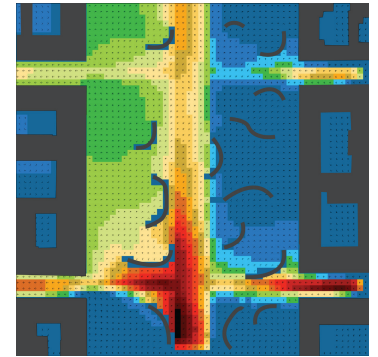
linear and continuous



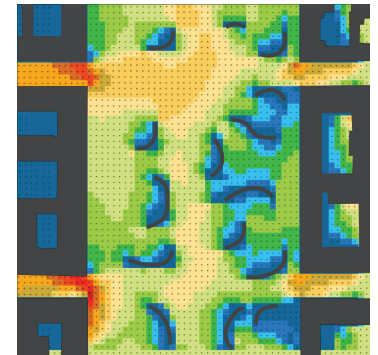
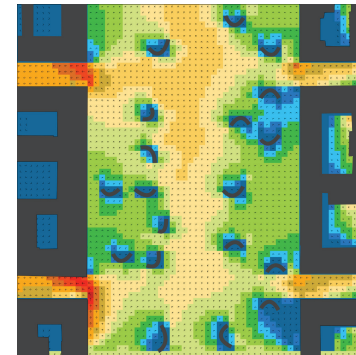
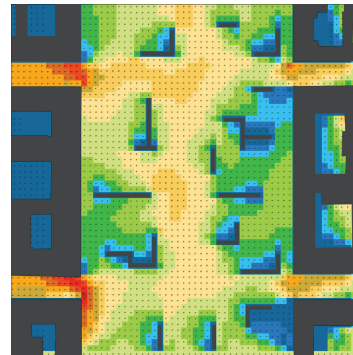
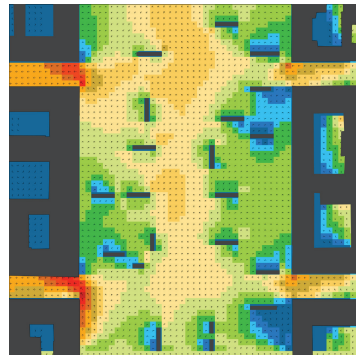
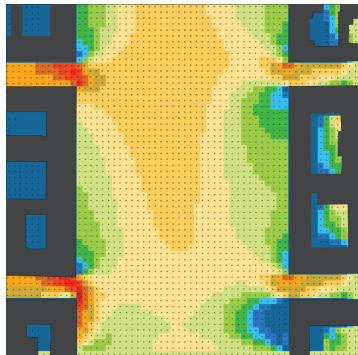
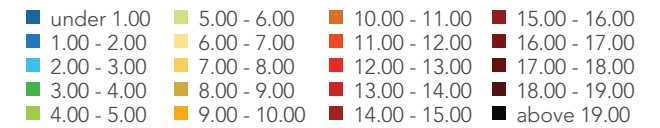
curvy and scattered



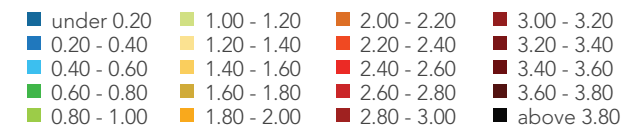
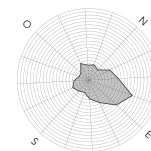
curvy and continuous



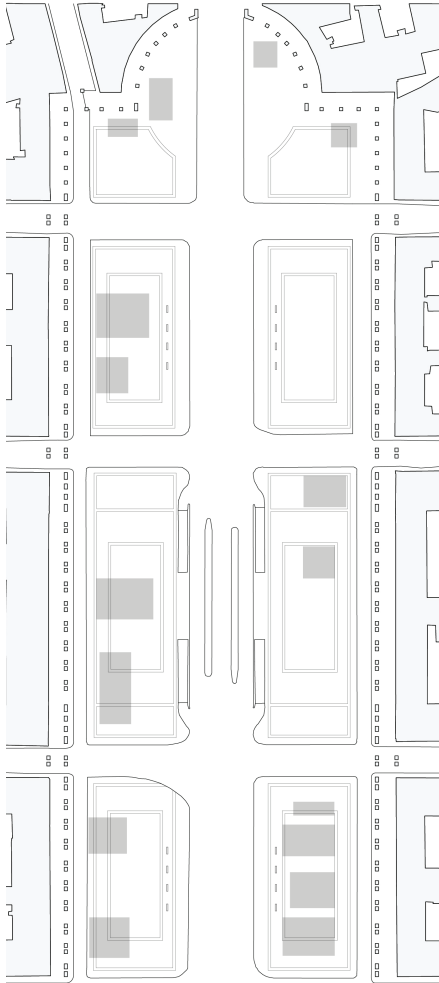
PM10 Concentration [mcg/m3]



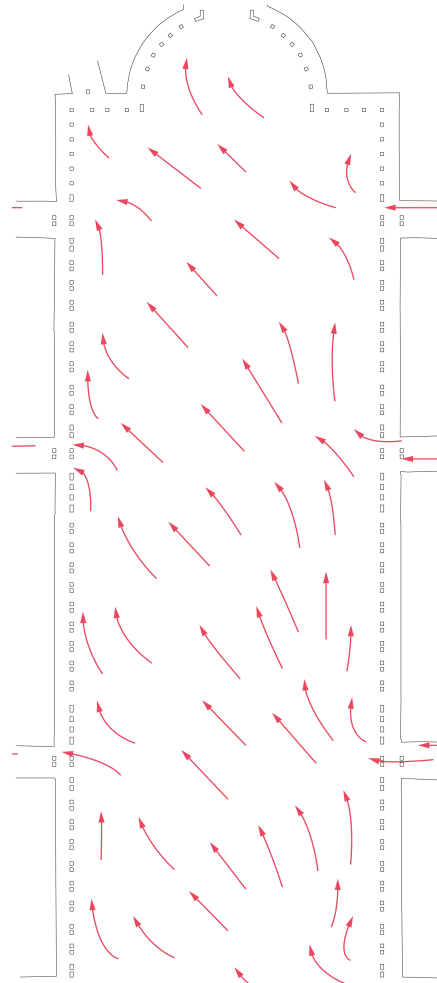
Wind Speed [m/s]



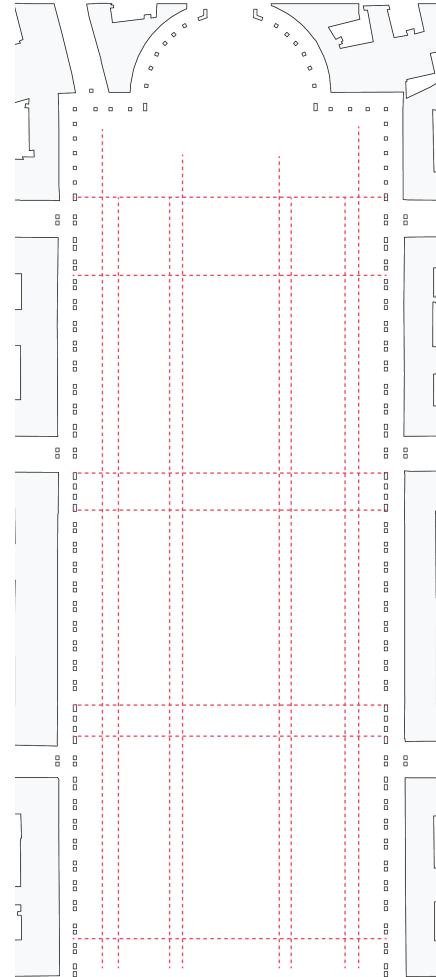
outdoors activities



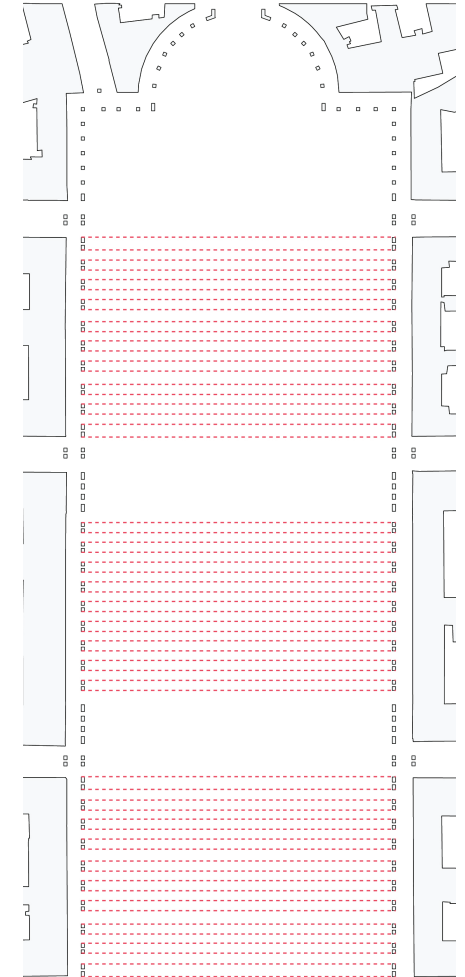
wind flow patterns

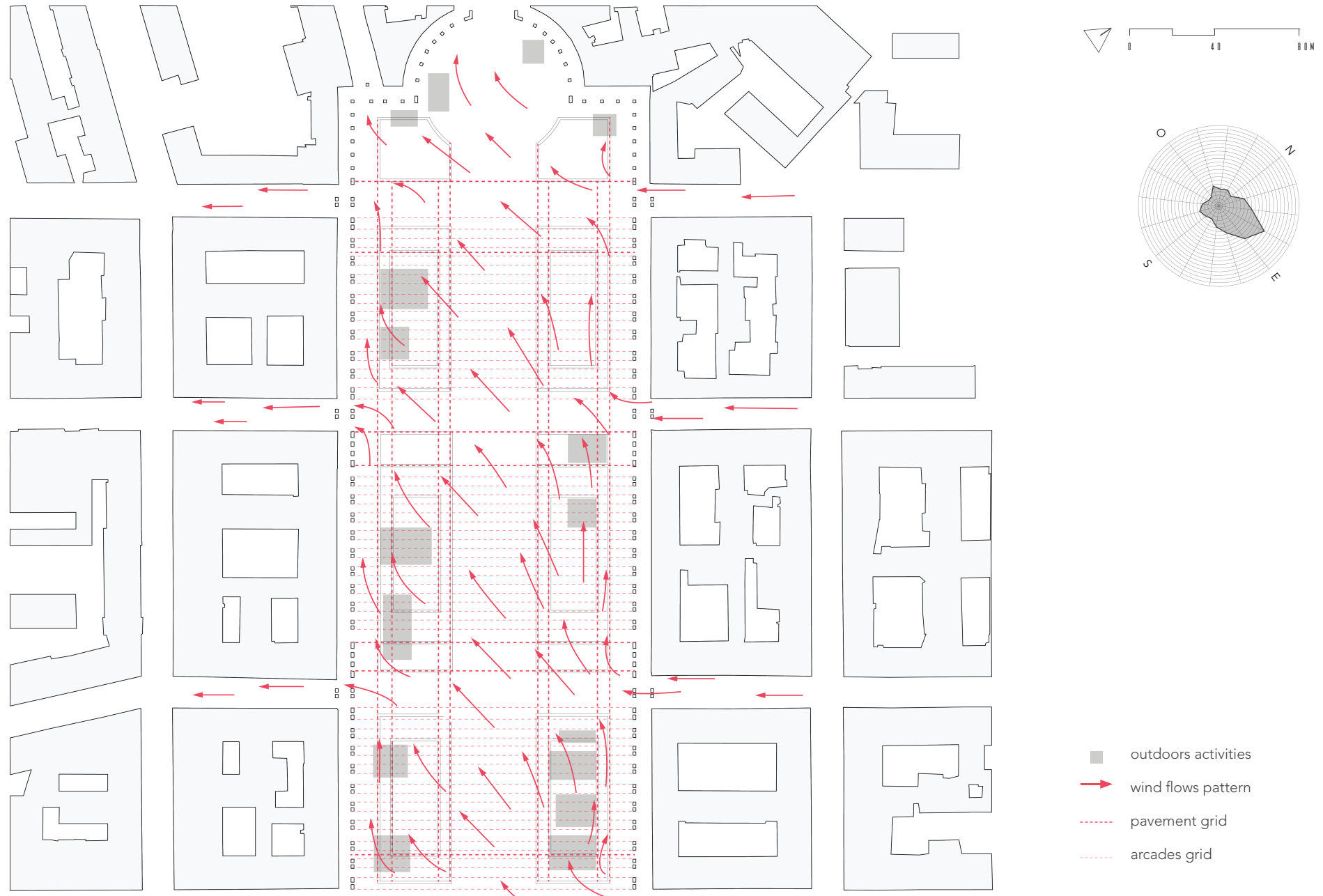


pavement grid



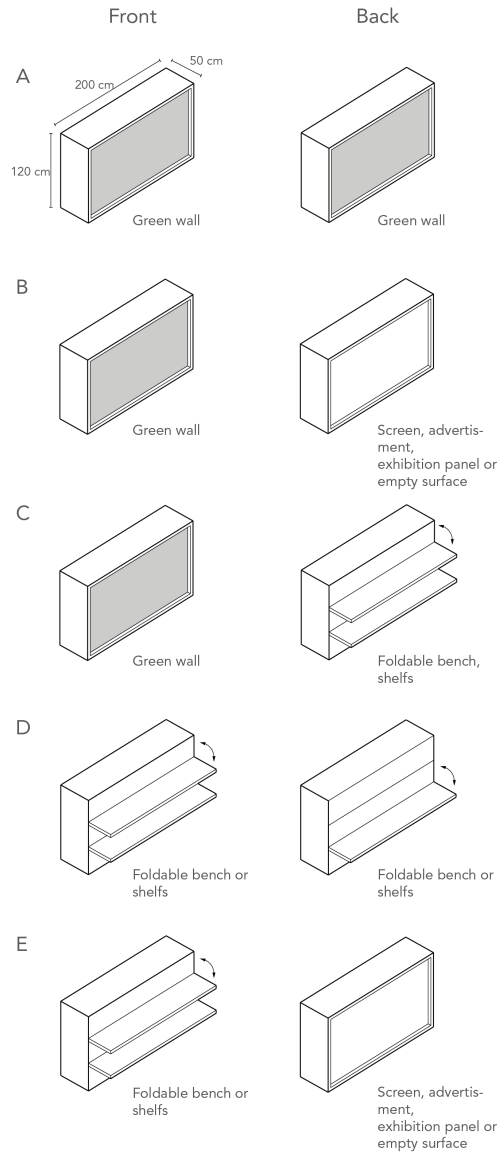
arcade grid





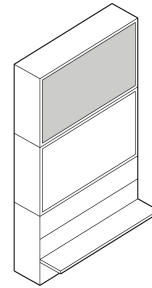
Modules

Possible combinations and functions

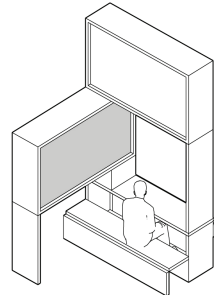
Filtering and
diverting effect

Diverting effect

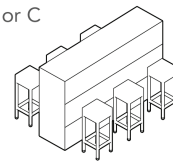
A + B + D



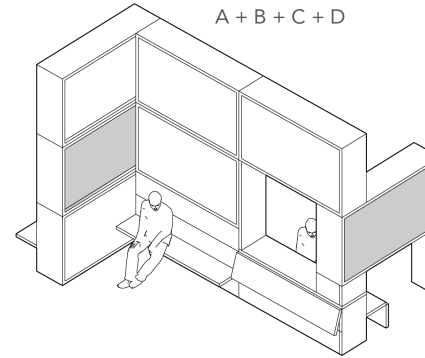
A + E



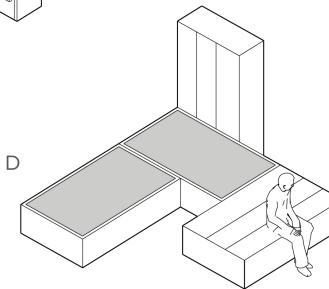
D or E or C



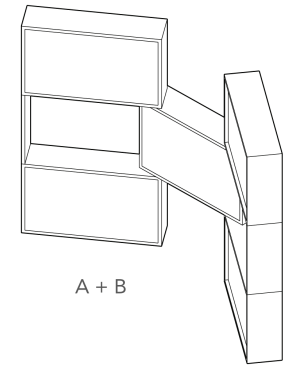
A + B + C + D



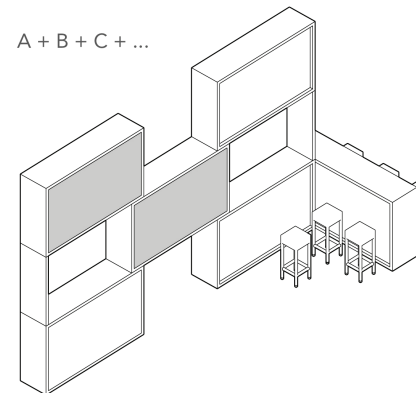
B or C or D



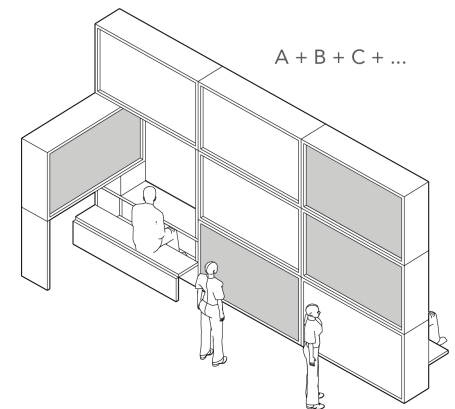
A + B

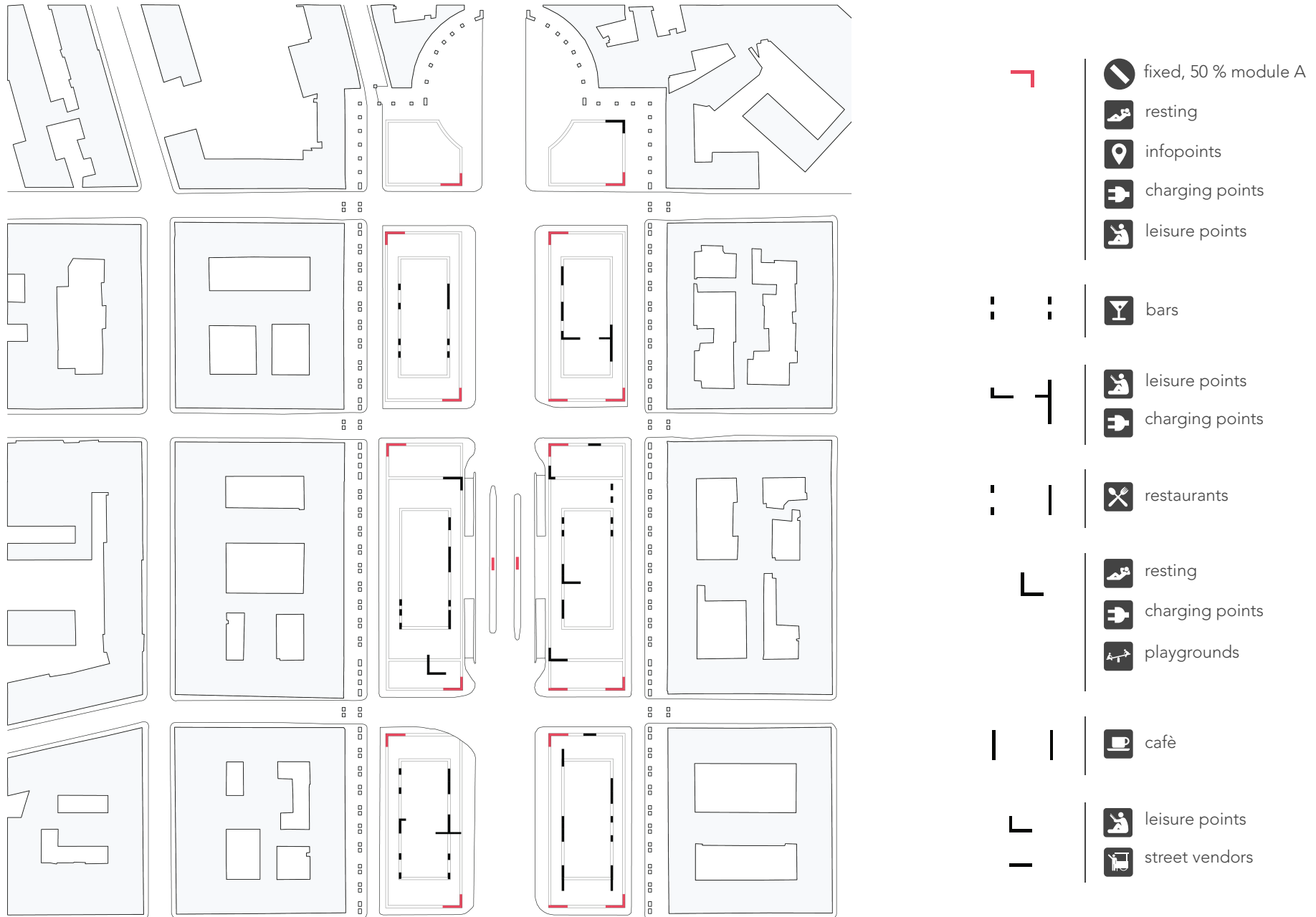


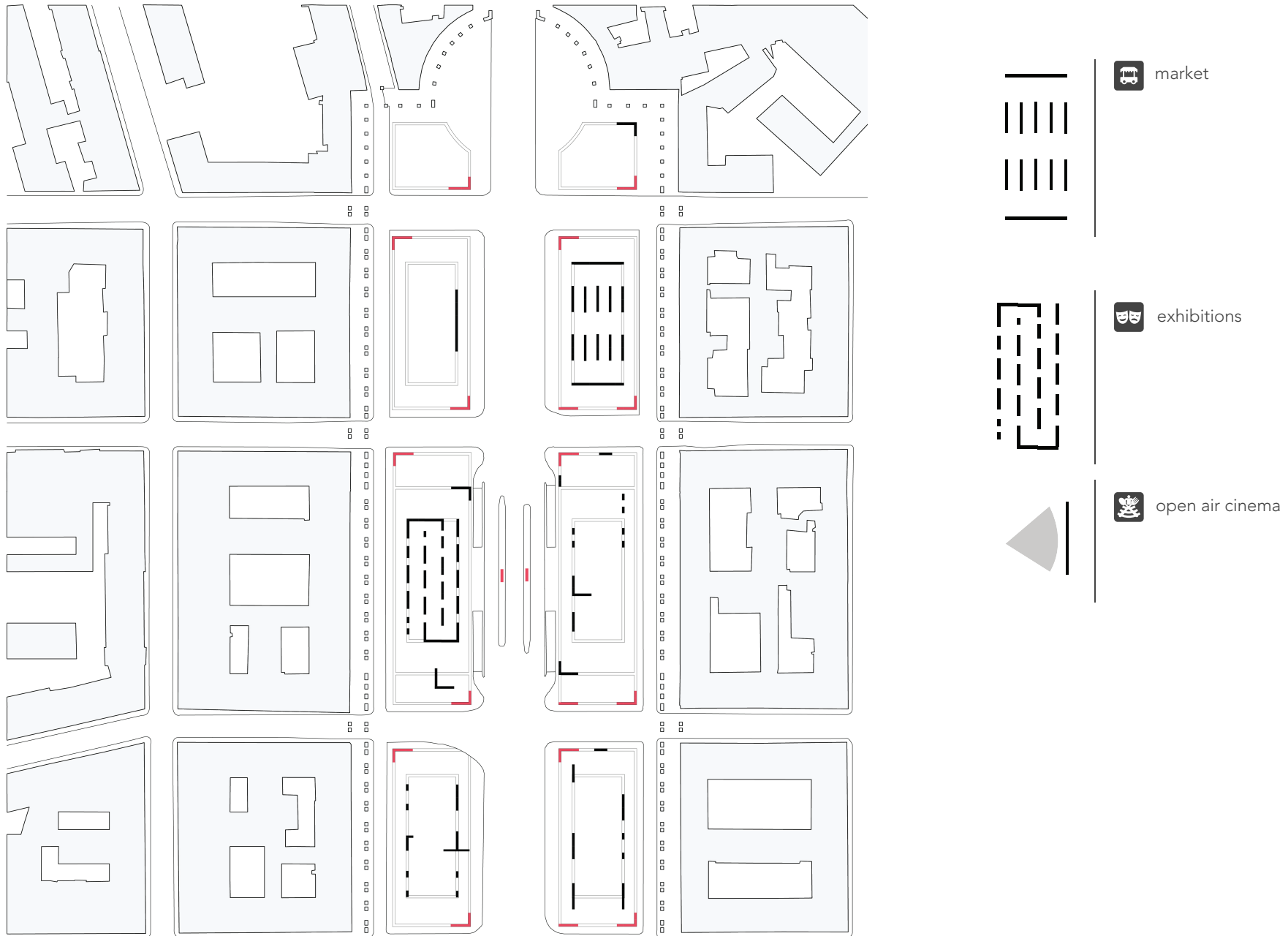
A + B + C + ...



A + B + C + ...











barriera di milano



source: derived from Google Earth



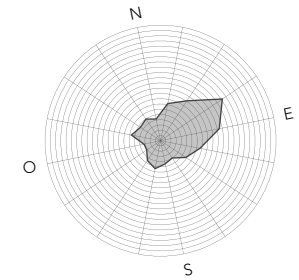
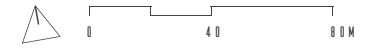
source: author



source: author

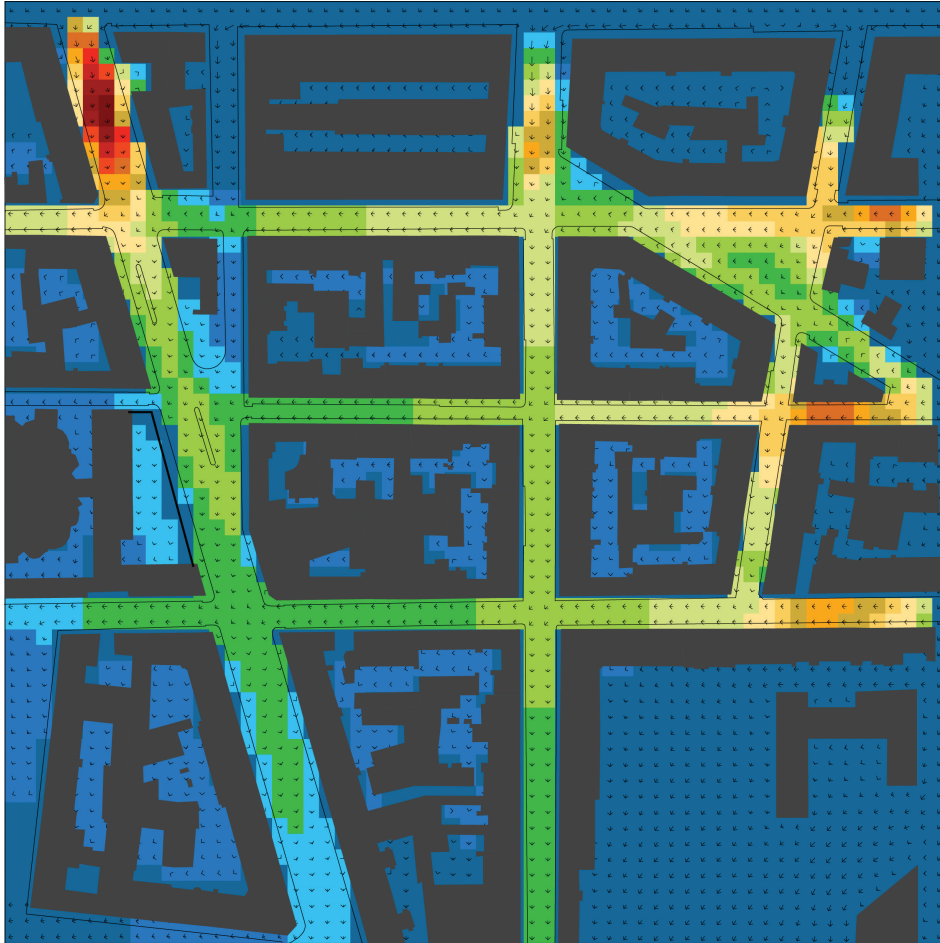


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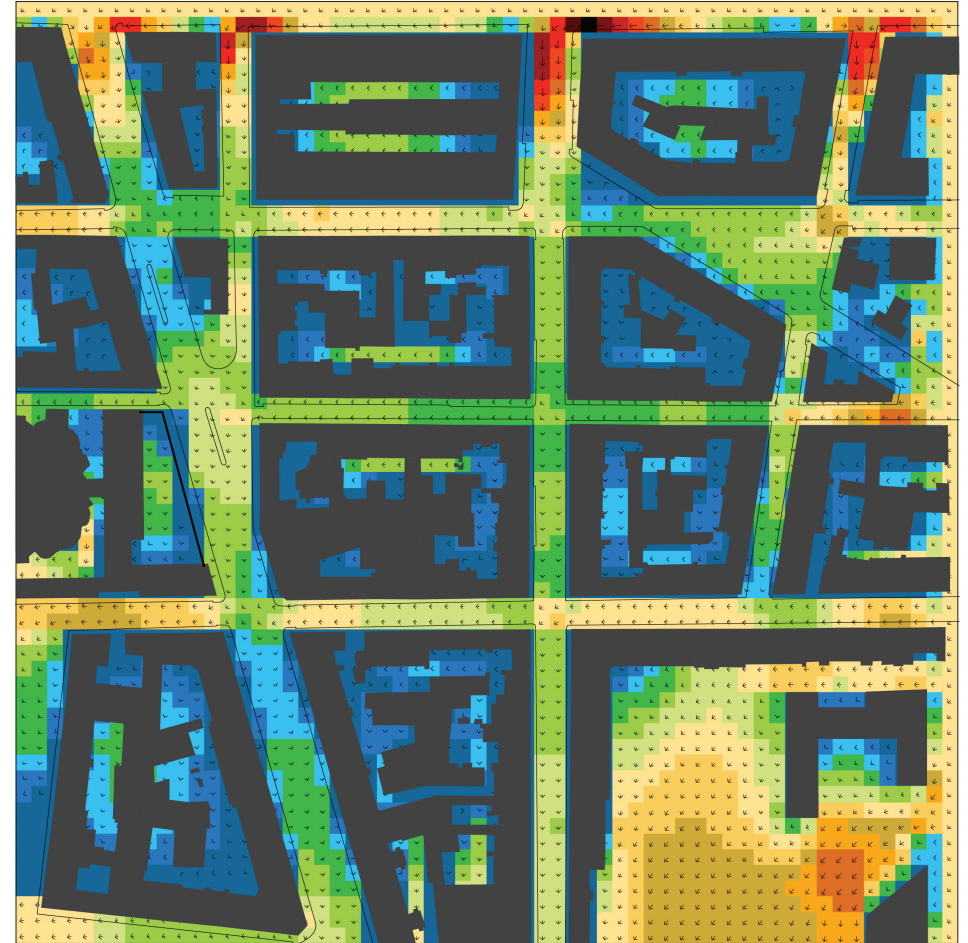
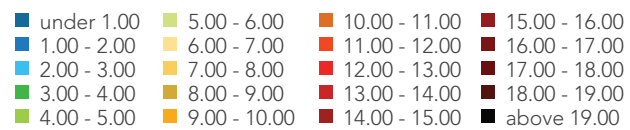


Land use

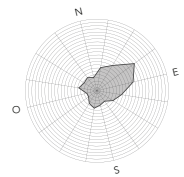
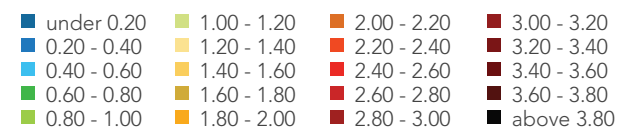
- S - Services
- ▨ R1 - Residential Type 1
- ▩ R2 - Residential Type 2
- ▧ R3 - Residential Type 3
- ▨ M - Mixed
- Grocery stores
- All the others



PM10 Concentration [mcg/m3]



Wind Speed [m/s]



air pollution mitigation

affecting wind flow patterns



providing green spaces

providing public spaces

new spatial quality and values

increasing social awareness

spatial qualities

green crosses

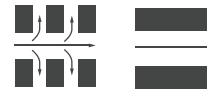
green courtyards

islands

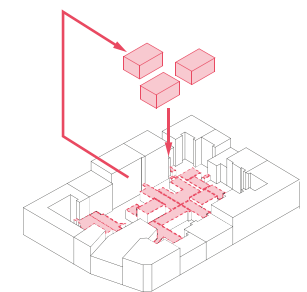
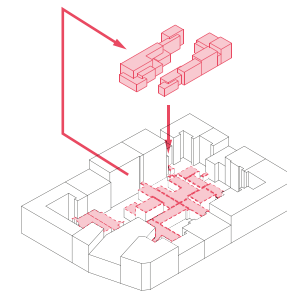
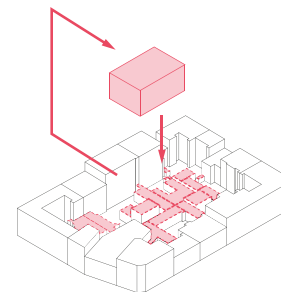
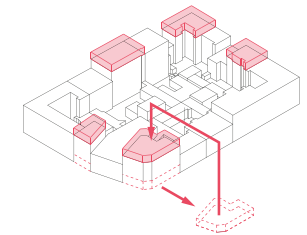
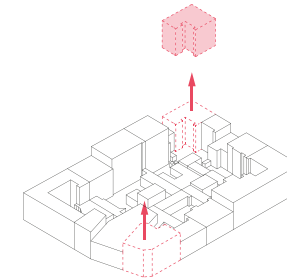
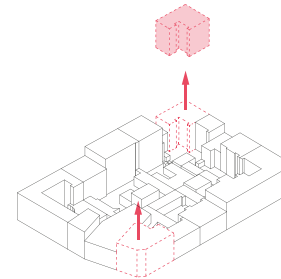
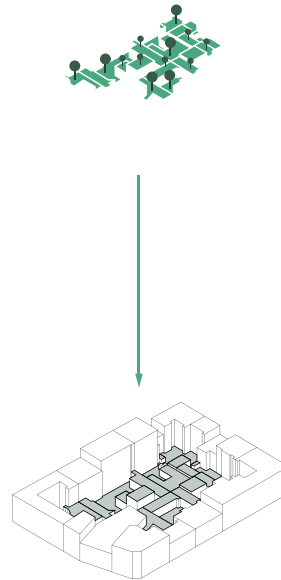
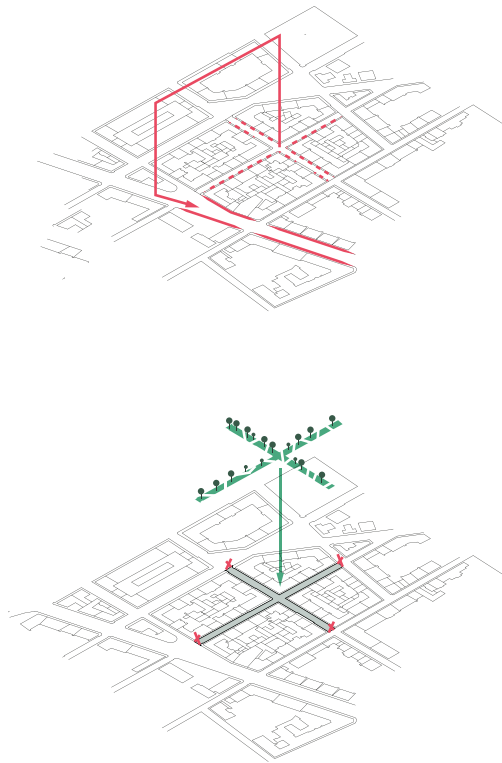
channelling

porosity

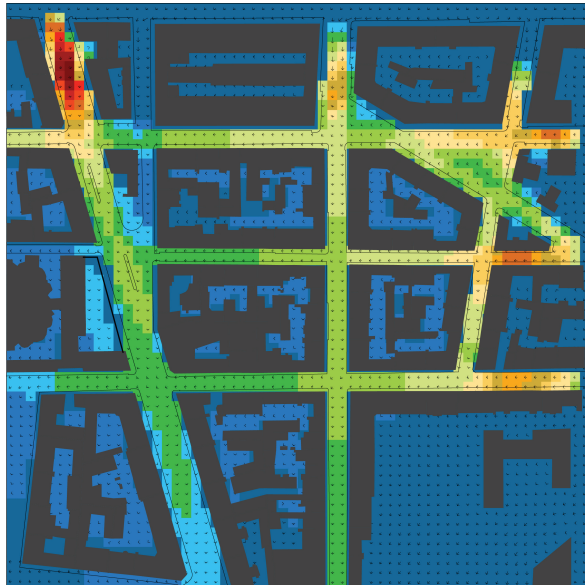
research



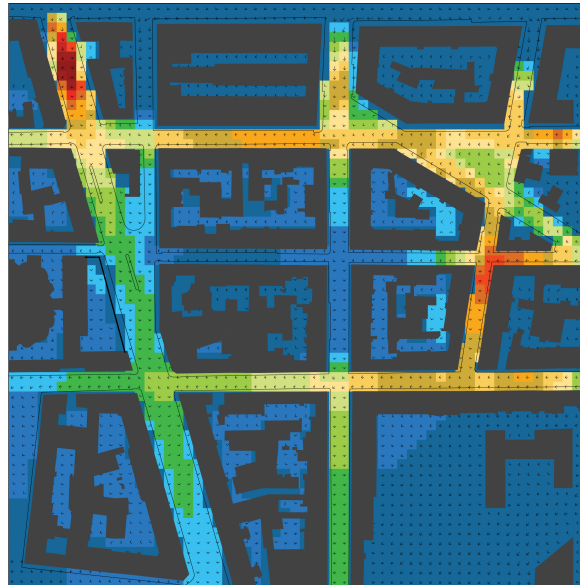
design principles



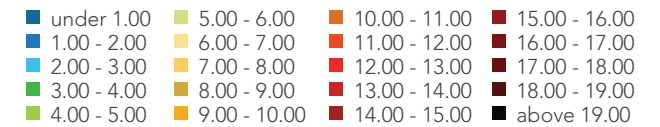
current



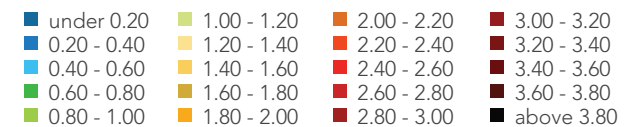
green crosses



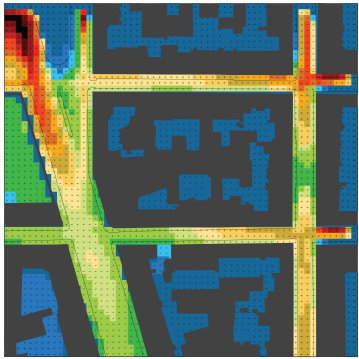
PM10 Concentration [mcg/m3]



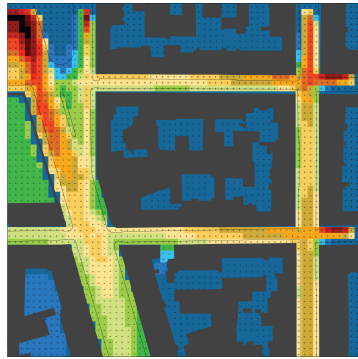
Wind Speed [m/s]



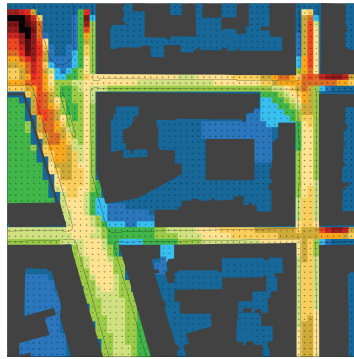
current



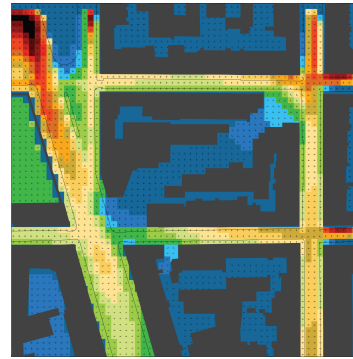
green courtyards



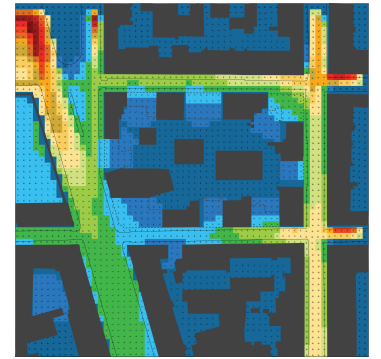
island



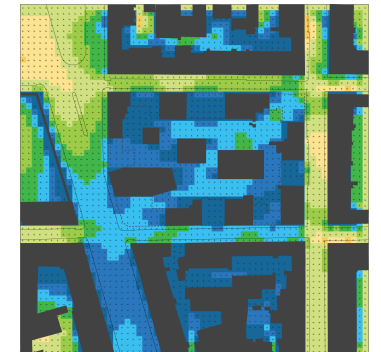
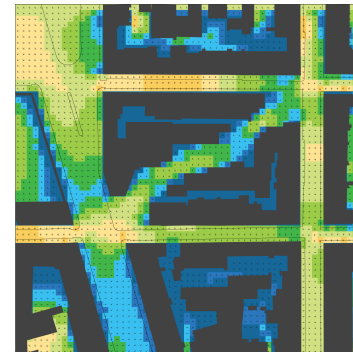
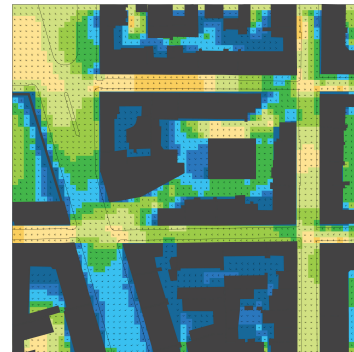
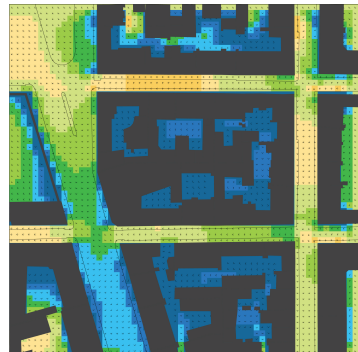
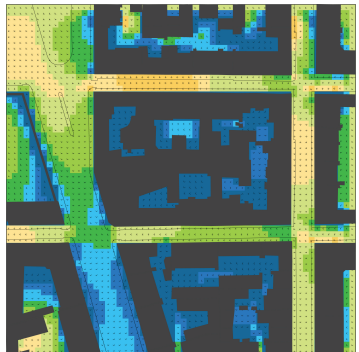
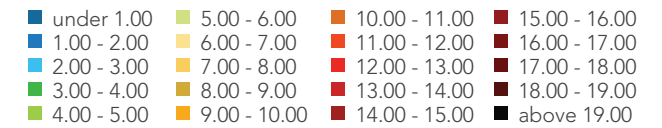
channeling



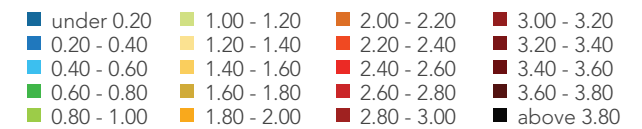
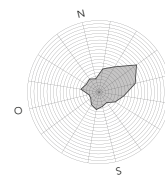
porosity



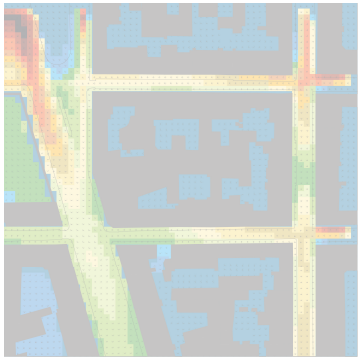
PM10 Concentration [mcg/m3]



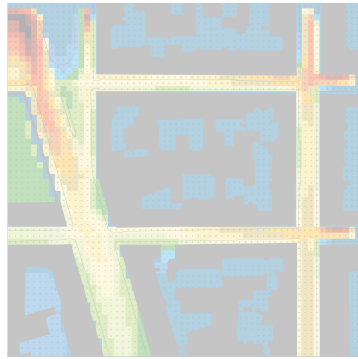
Wind Speed [m/s]



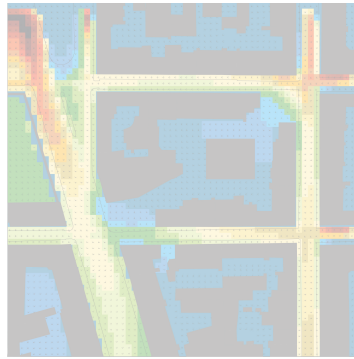
current



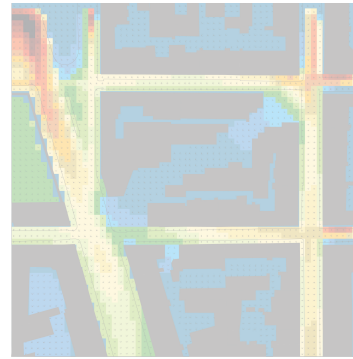
green courtyards



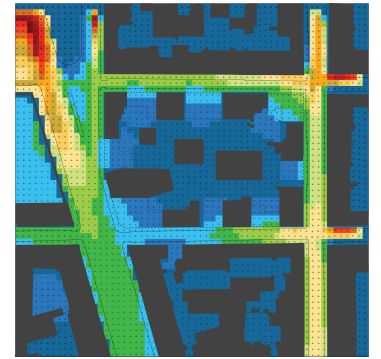
island



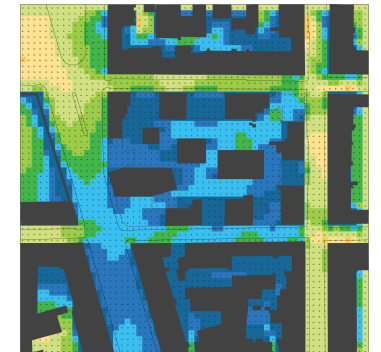
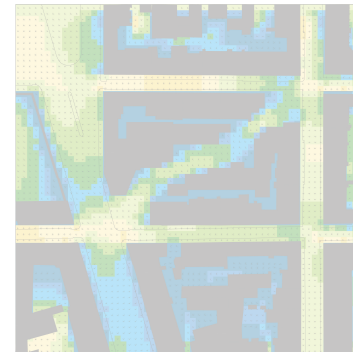
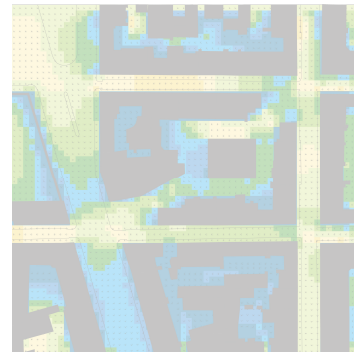
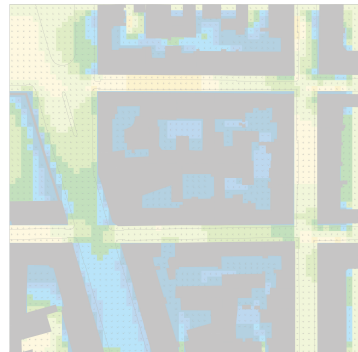
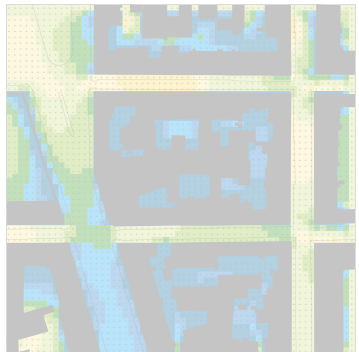
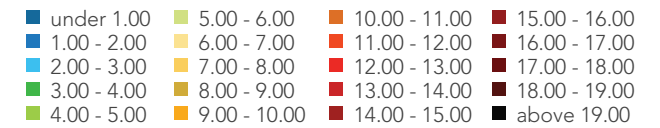
channeling



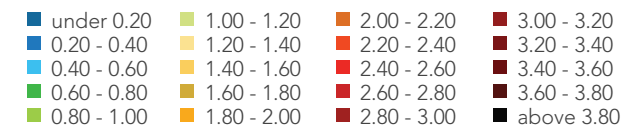
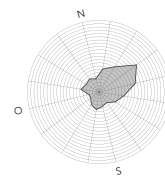
porosity

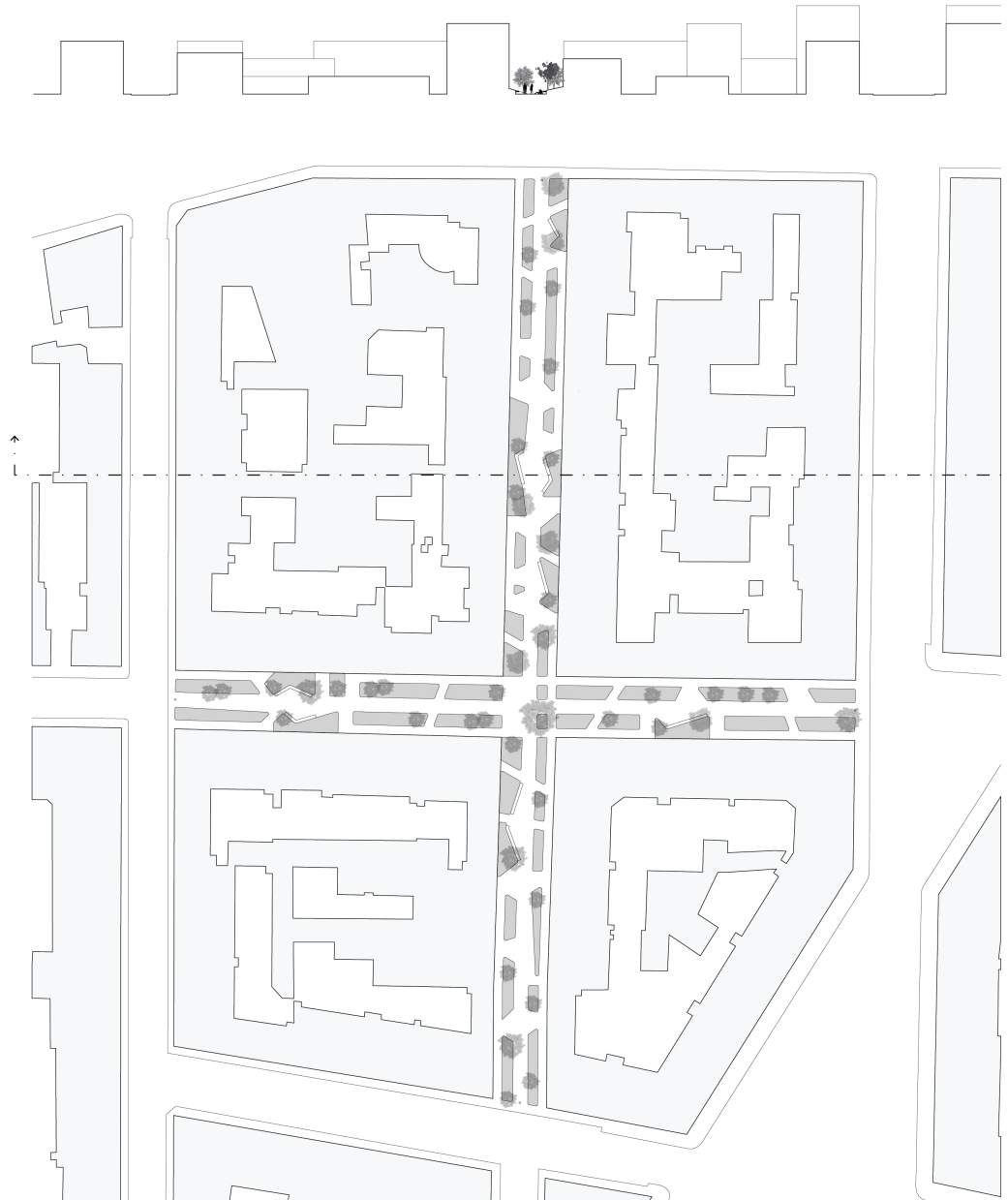


PM10 Concentration [mcg/m3]

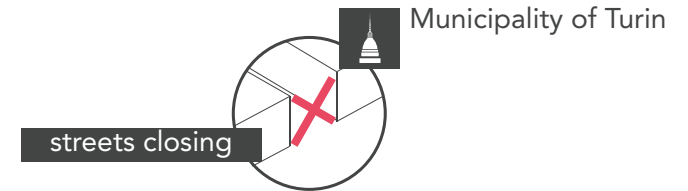


Wind Speed [m/s]

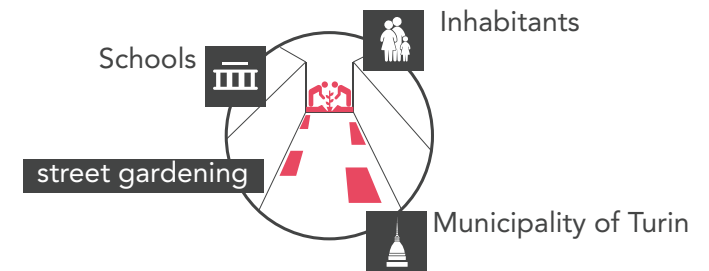




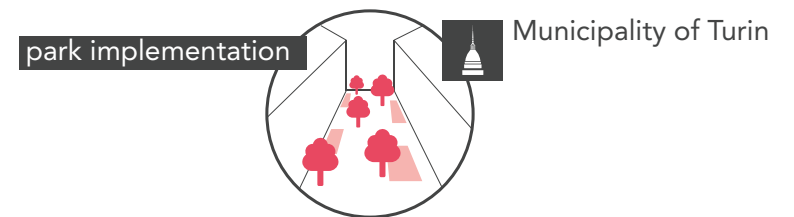
phase I



phase II



phase III



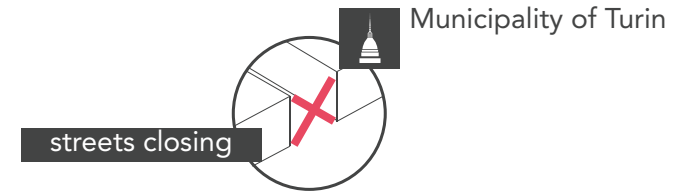


source: author

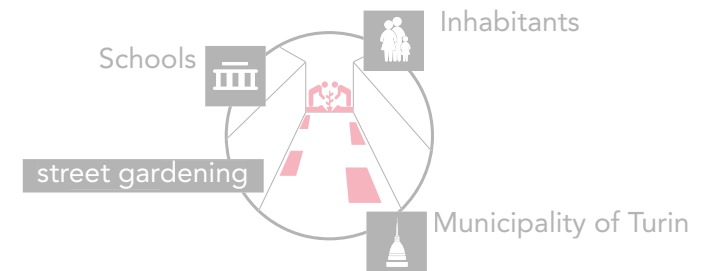


source: <https://addictlab.wordpress.com/2013/06/03/addictlab-on-the-greenweek-2013/>

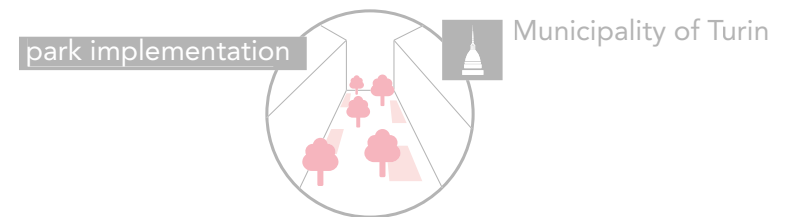
phase I



phase II



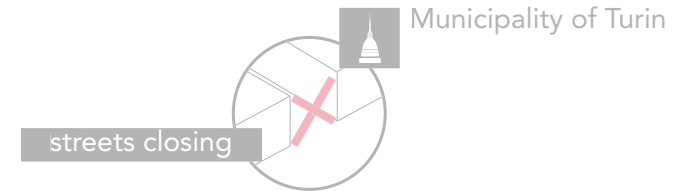
phase III



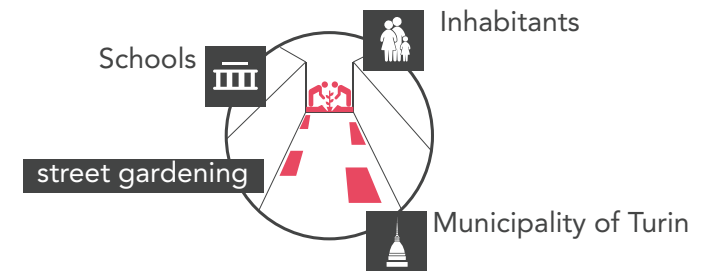
source: <http://www.gushmag.it/come-ti-trasformo-laiuola-il-guerrilla-gardening/>



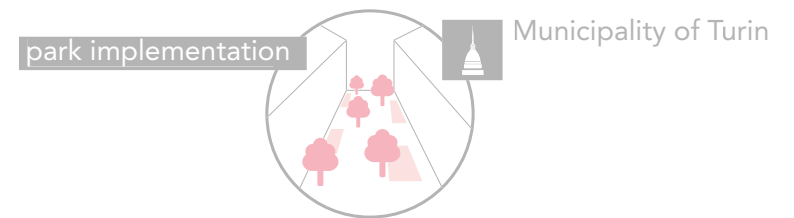
phase I



phase II



phase III



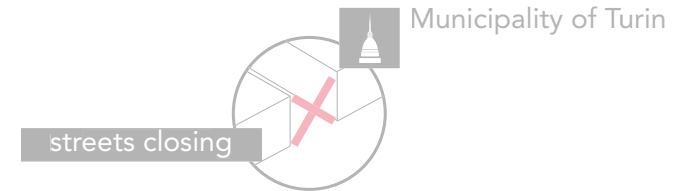
source: <http://www.ecoreport.tv/video-guerrilla-gardening-la-lotta-dei-giardinieri-sowversiv/>



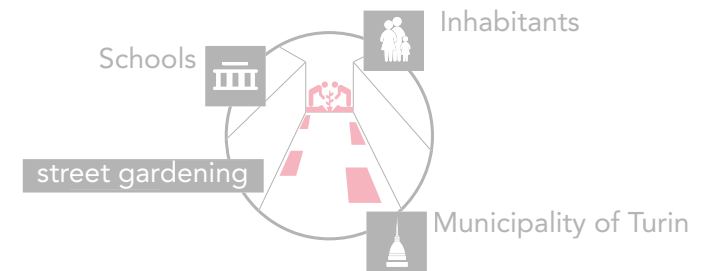


source: <http://oogopnederland.nl/delft/2015/06/24/de-tuinstraat-doet-zijn-naam-eer-aan/>

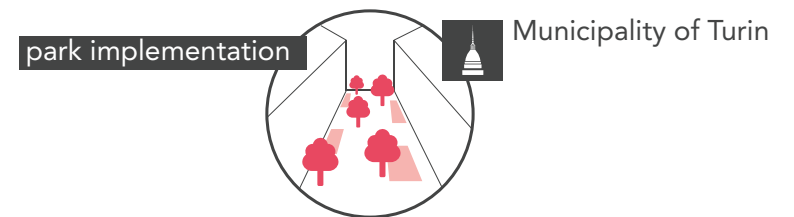
phase I



phase II

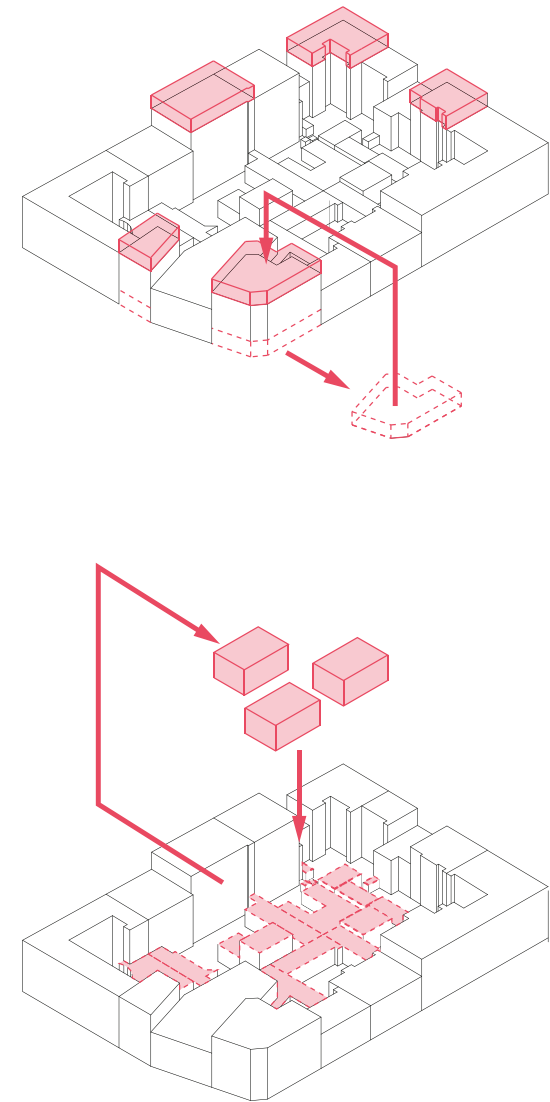


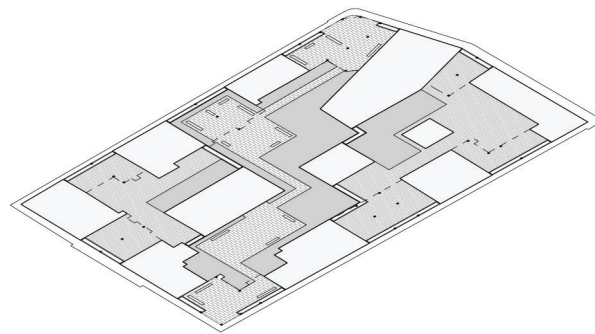
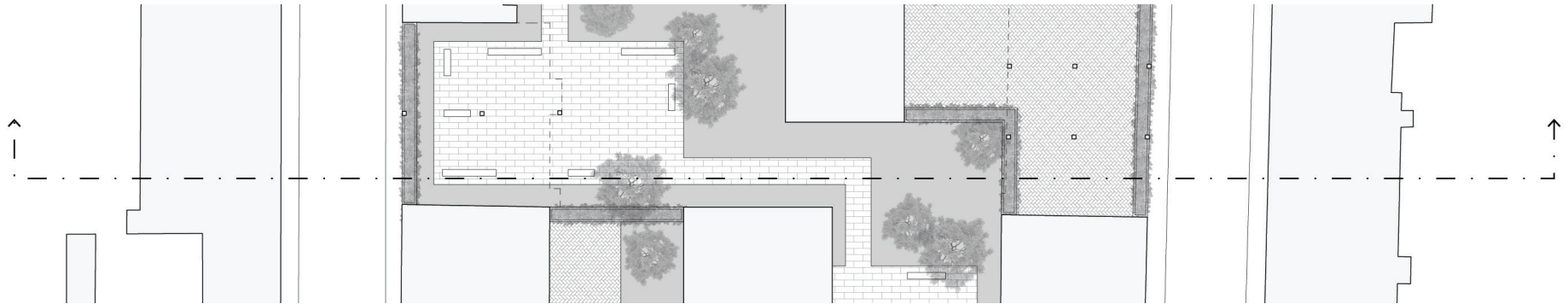
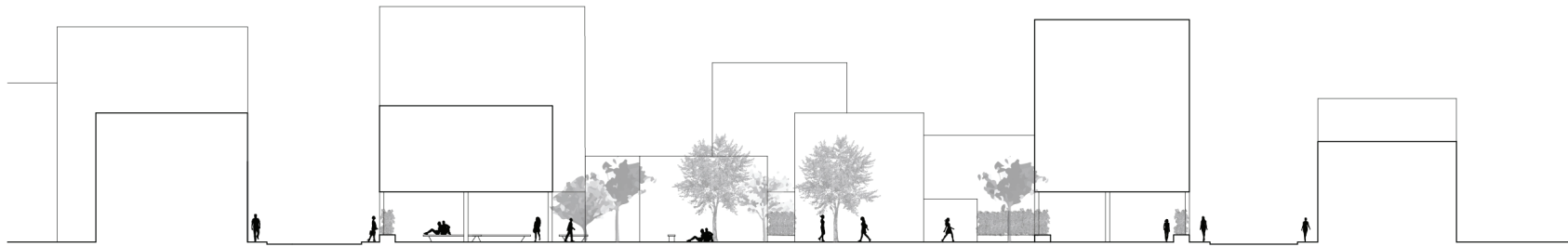
phase III



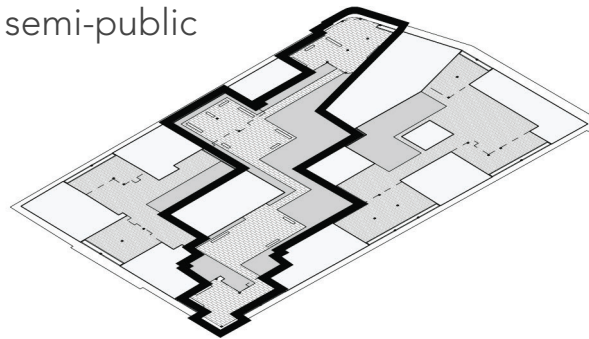




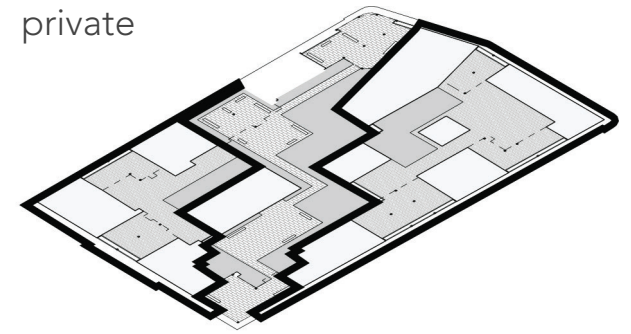




semi-public



private













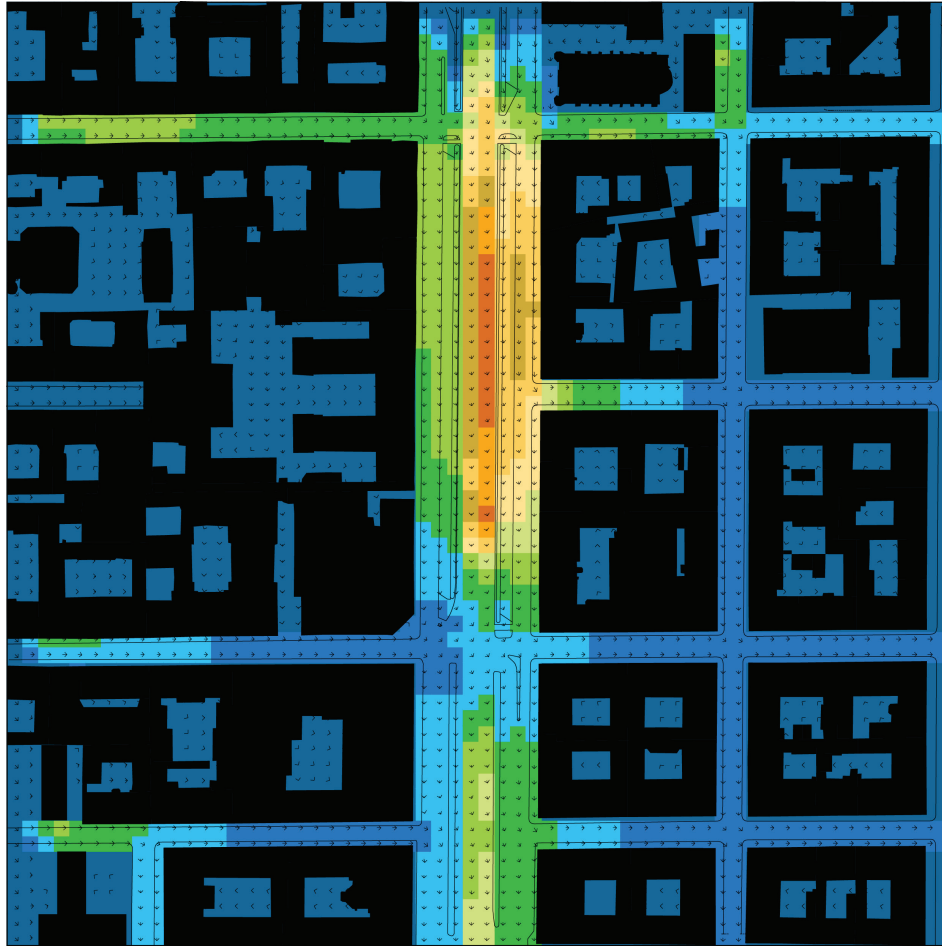
corso vittorio



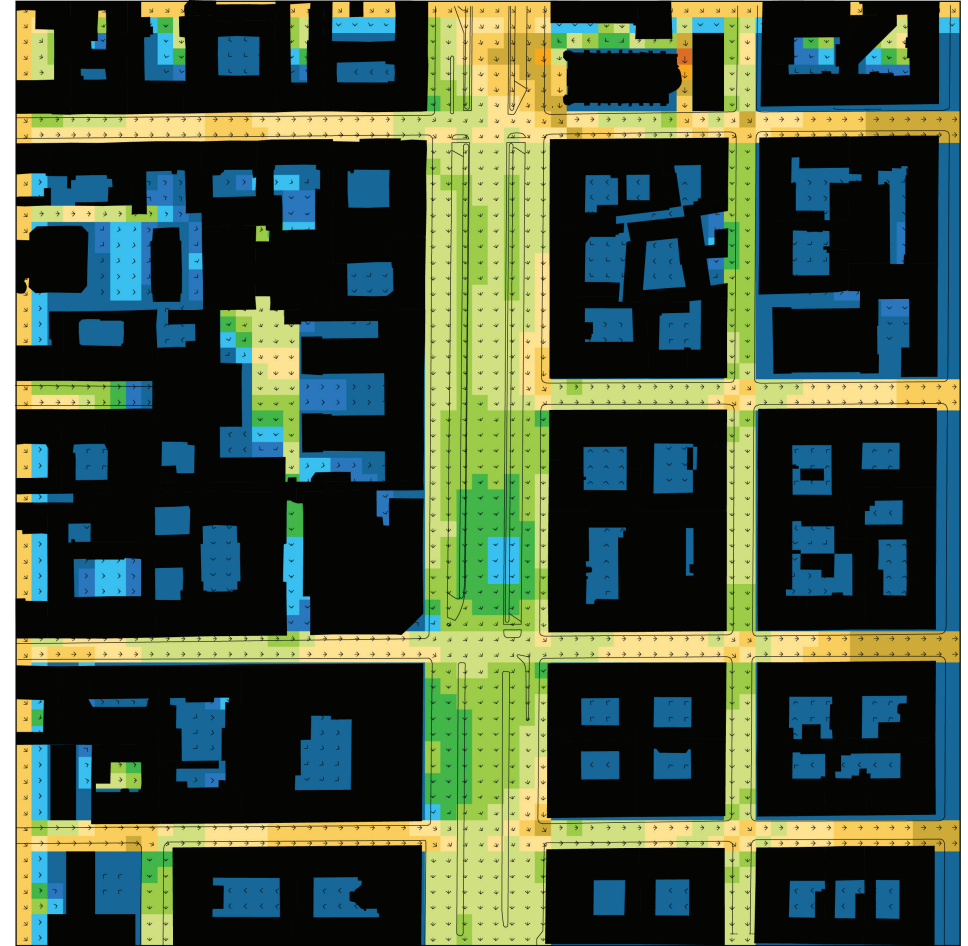
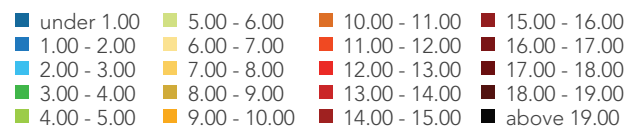


source: Google Earth

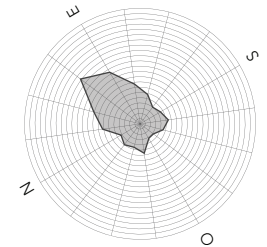
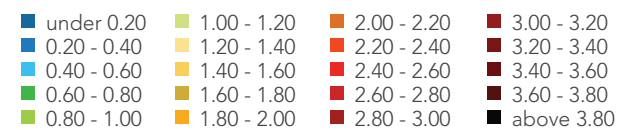


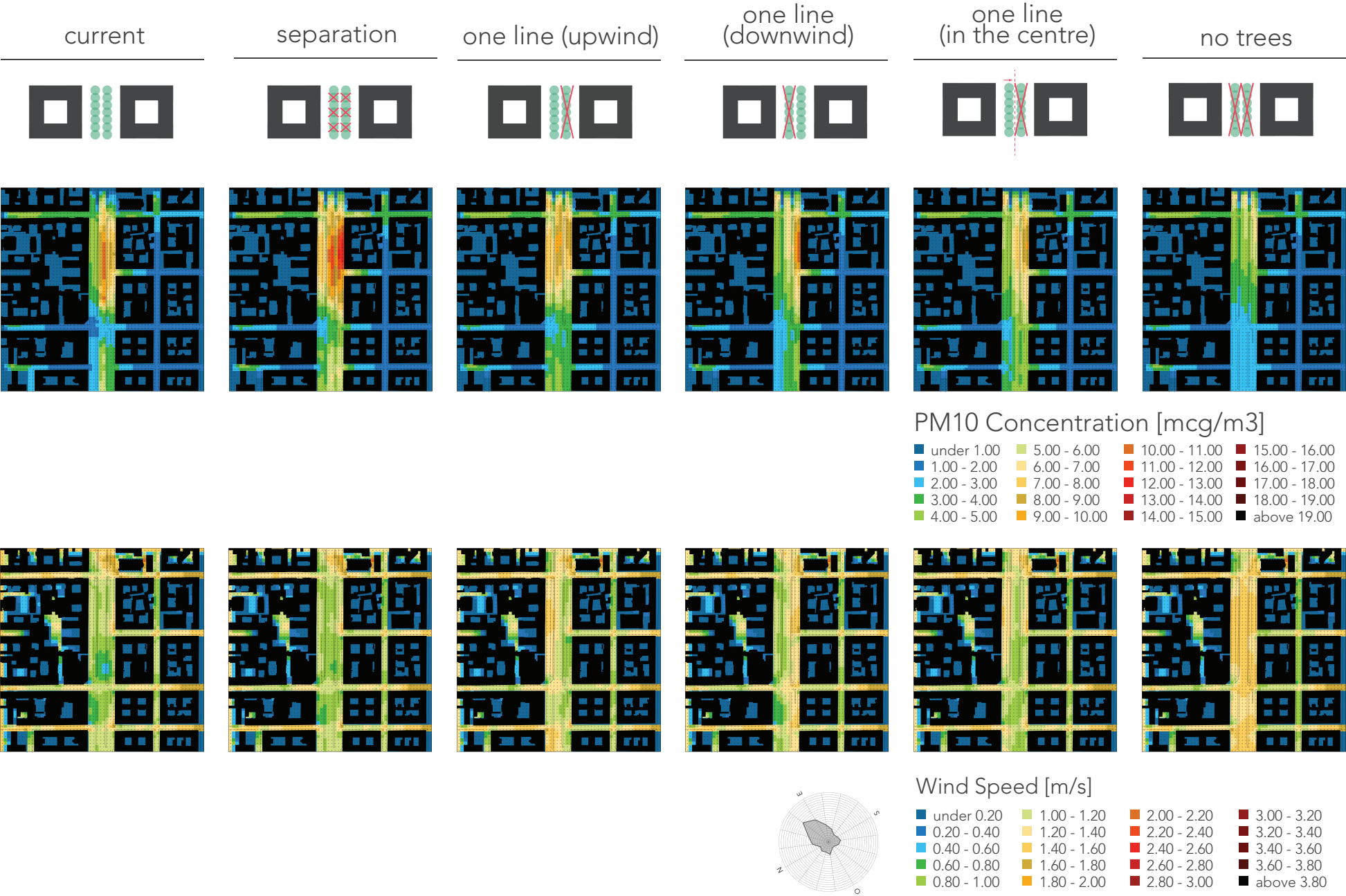


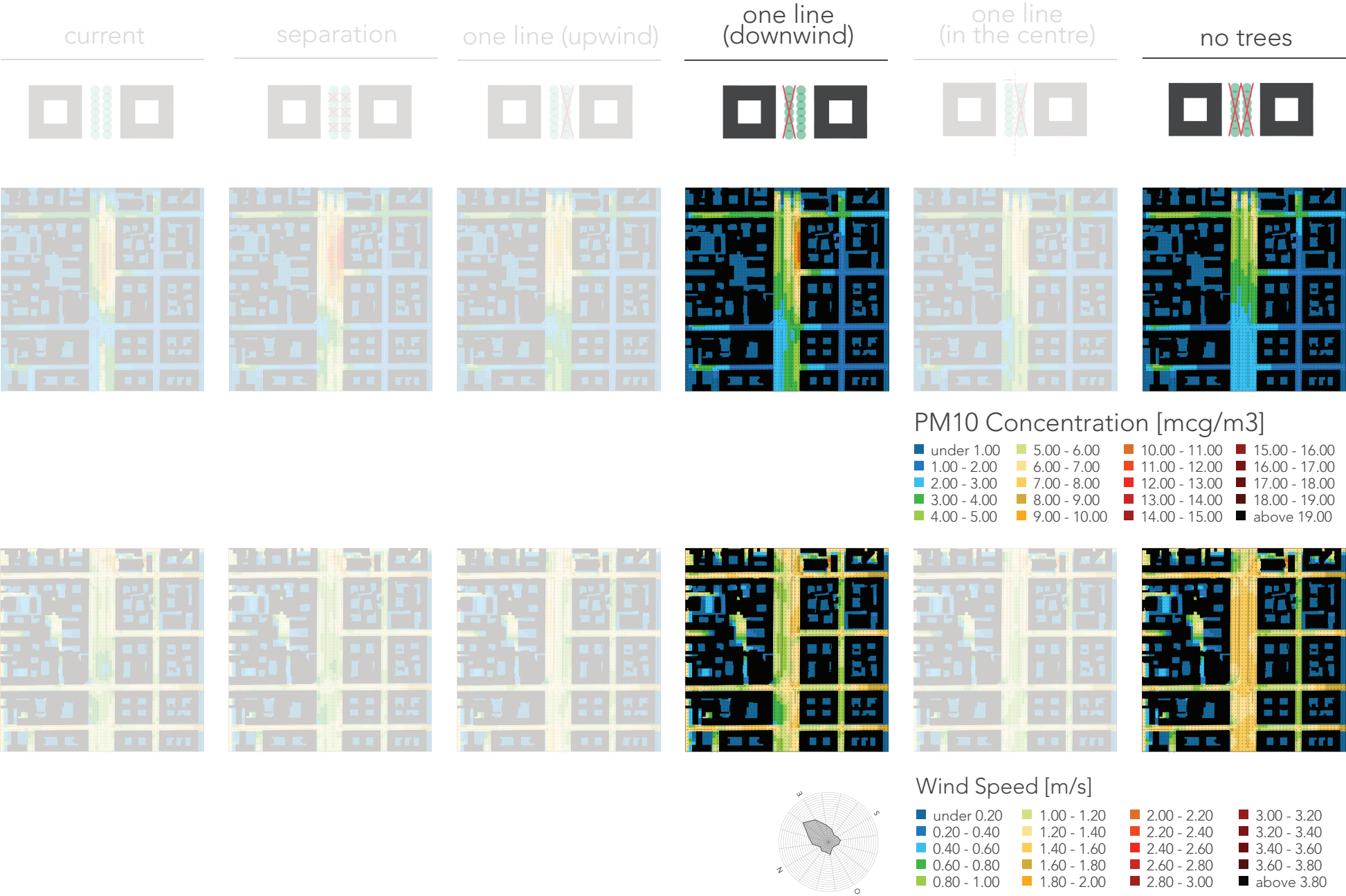
PM10 Concentration [mcg/m3]



Wind Speed [m/s]

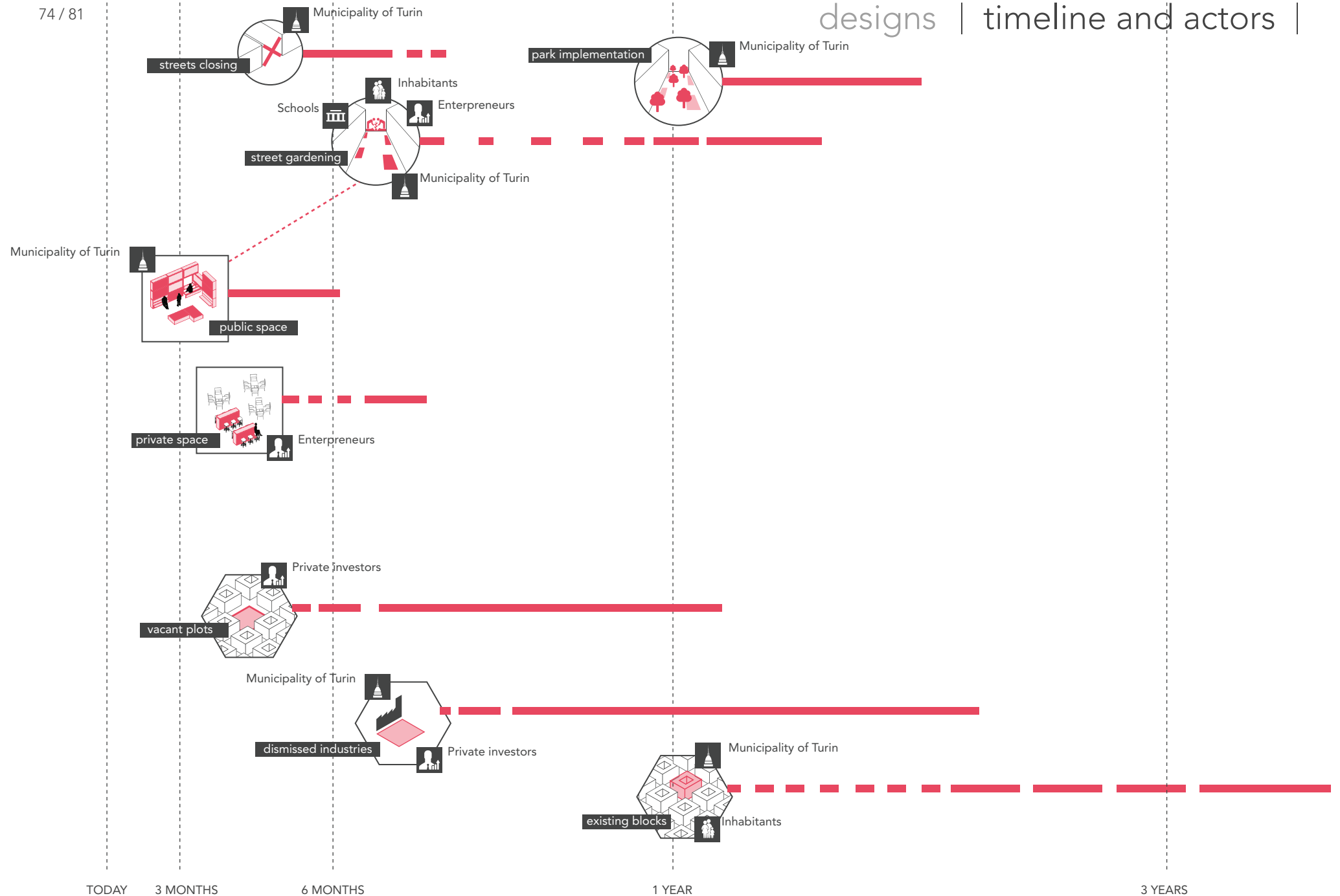


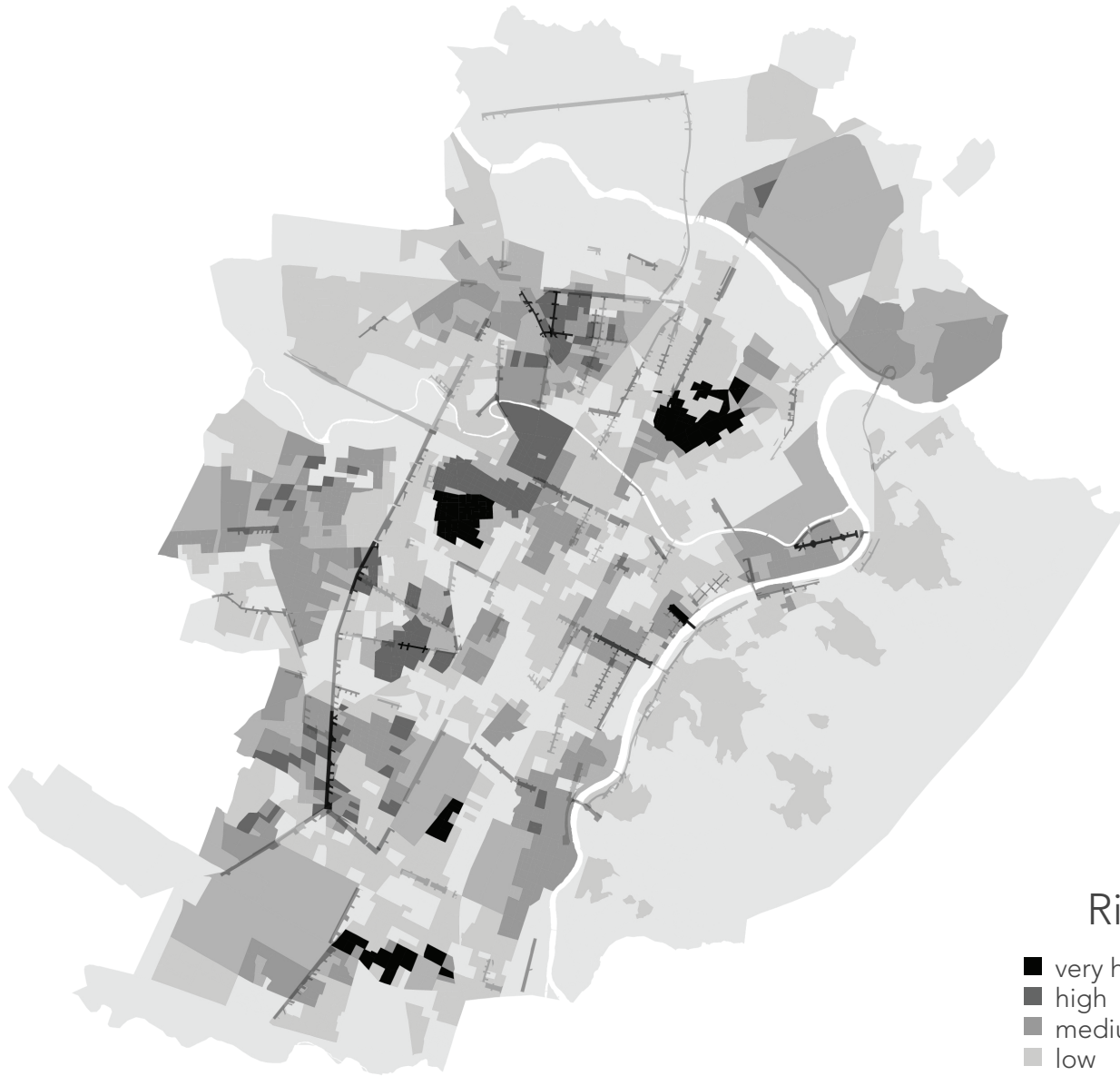
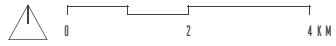


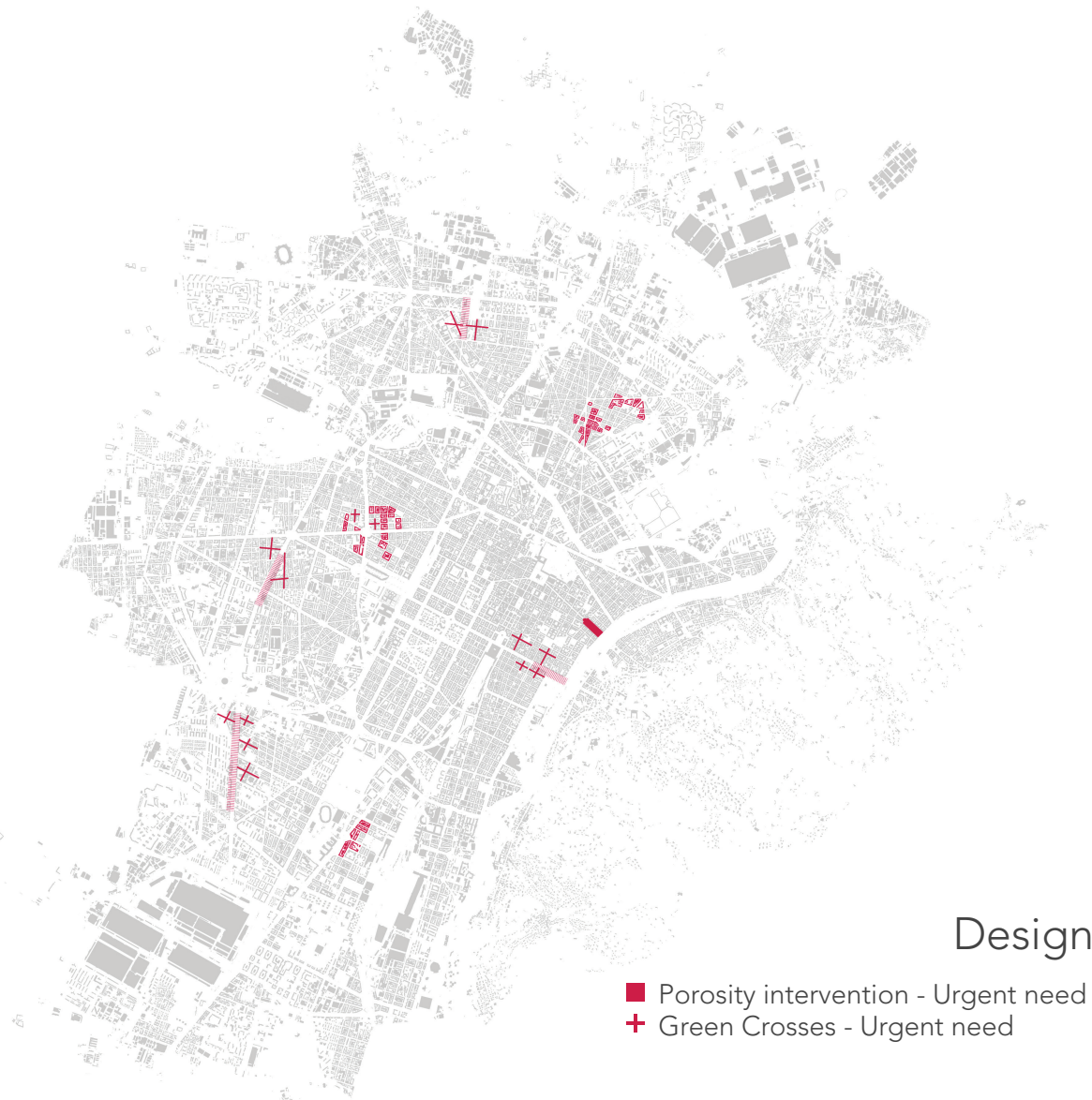
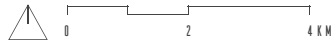


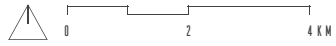


conclusions



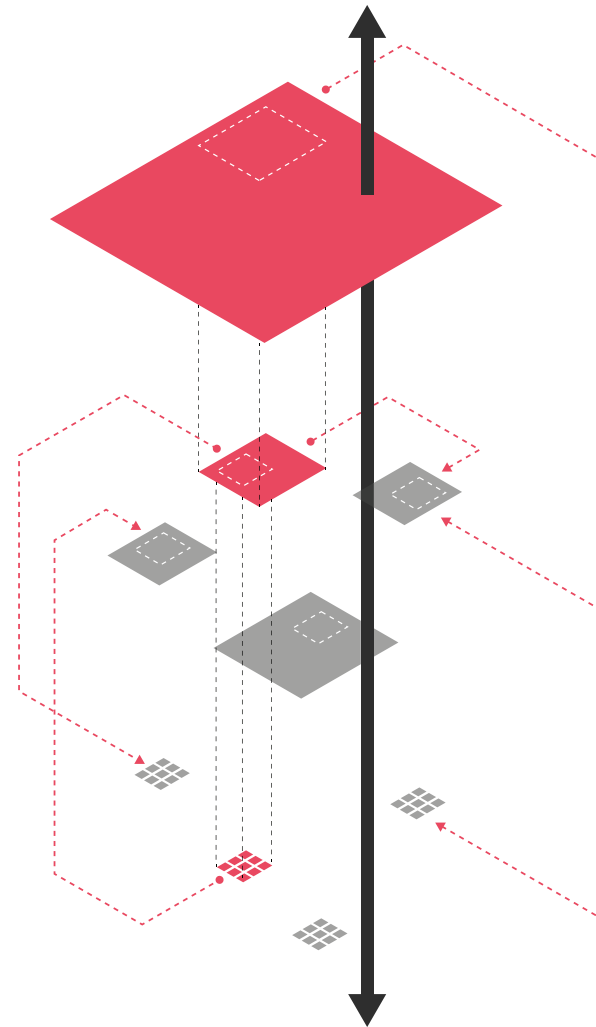




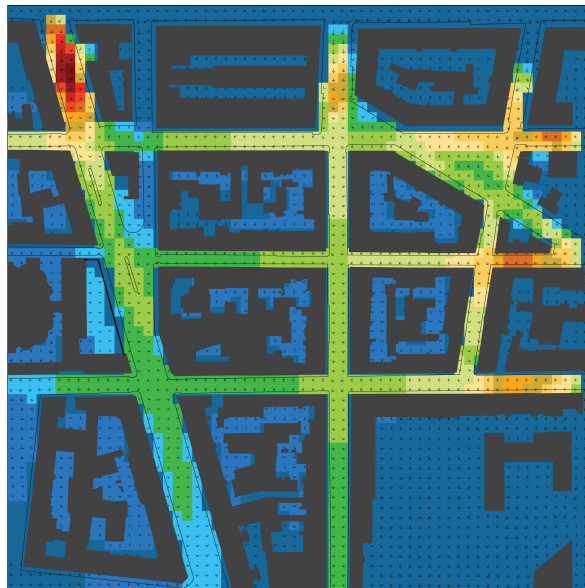


Design

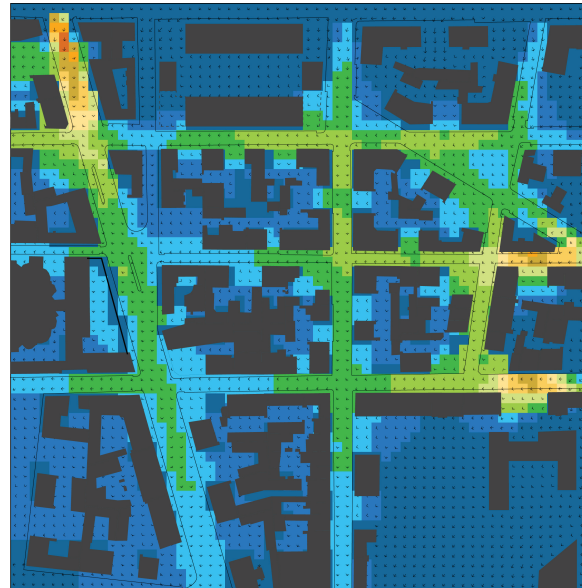




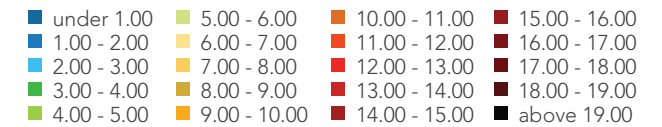
current



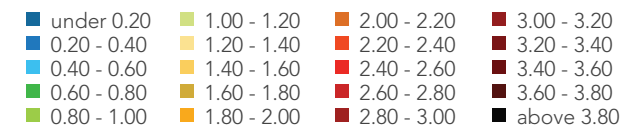
porosity - upscaled

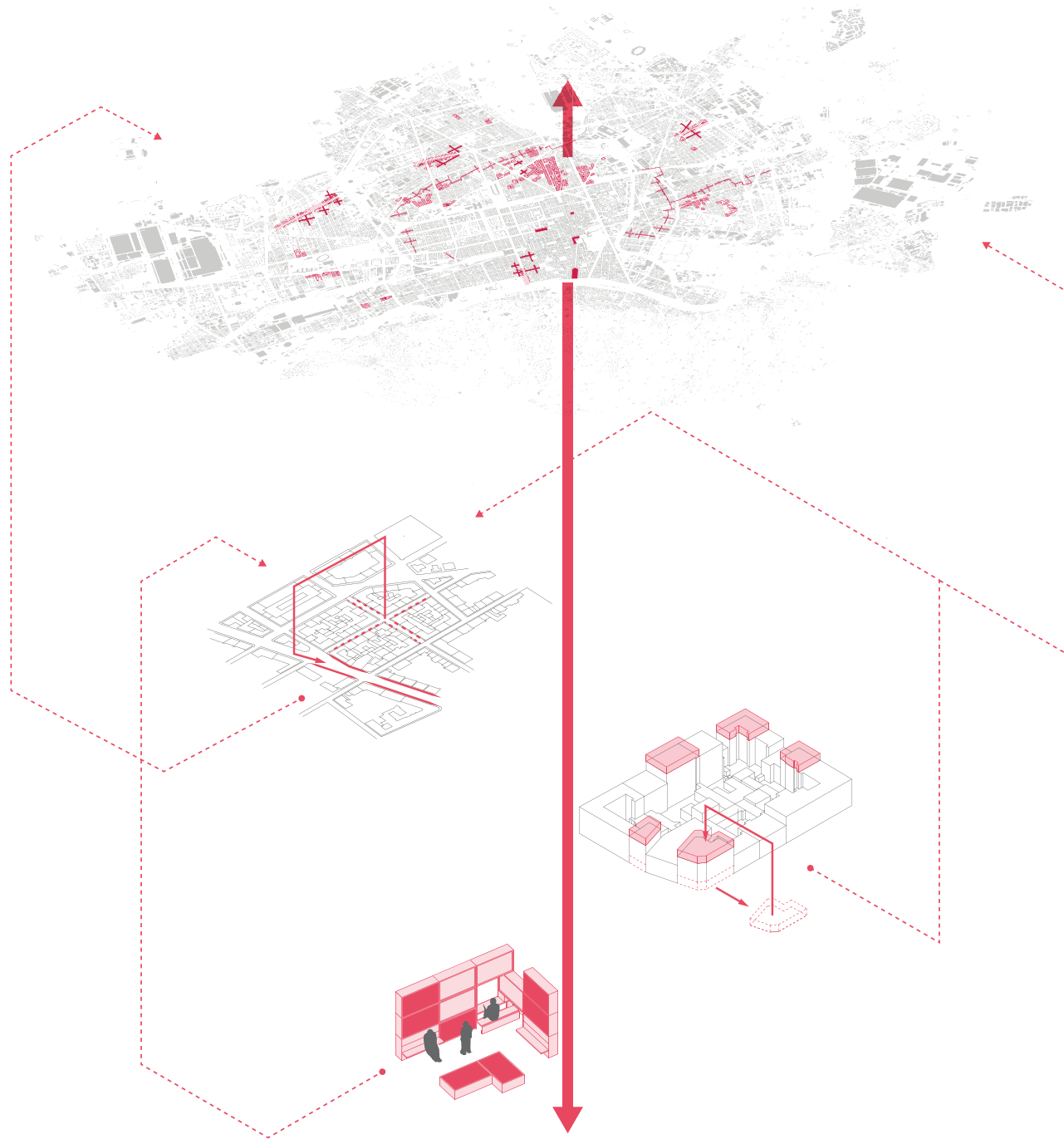


PM10 Concentration [mcg/m3]



Wind Speed [m/s]





The **design interventions** do not only build a thorough interscalr approach able to **mitigate air pollution**, but they also **add spatial values** to the space.



thank you.

