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iSCAPE Final Event

Case Studies: Key Learnings and Recommendations

Session Chair
Professor Prashant Kumar
University of Surrey, United Kingdom

Dublin, Ireland
8 November 2019

Session Overview

Overview

Summary of the key findings and recommendations

- General urban planning – TUDO
- PCS in open-road conditions & street canyons
  - Hedges and trees in open road environment – UoS
  - Trees in street canyons and Photocatalytic coating – UNIBO
  - Low-boundary wall – UCD
- Behavioural change – UH

Interactions between air pollution & climate change: key findings

- Introduction – UoS
- Climate change – FMI
- AQ & Climate change – UNIBO

Concluding Remarks

Q&A

Speakers

Moderator:
Prashant Kumar, Professor, University of Surrey (UK)

Speakers:
Marisa Fuchs, Researcher, Technical University of Dortmund (Germany)
Prashant Kumar, Professor, University of Surrey (UK)
Erika Brattich, Assistant Professor, University of Bologna (Italy)
Bidroha Basu, Researcher, University College Dublin (Ireland)
Muhammad Adnan, Researcher, Hasselt University (Belgium)
Antti Mäkelä, Head of Group, Finnish Meteorological Institute (Finland)

Contributing Partners

D7.2 Generalised Recommendations

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UCD DUBLIN

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA A.D. 1088

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

UHASSELT

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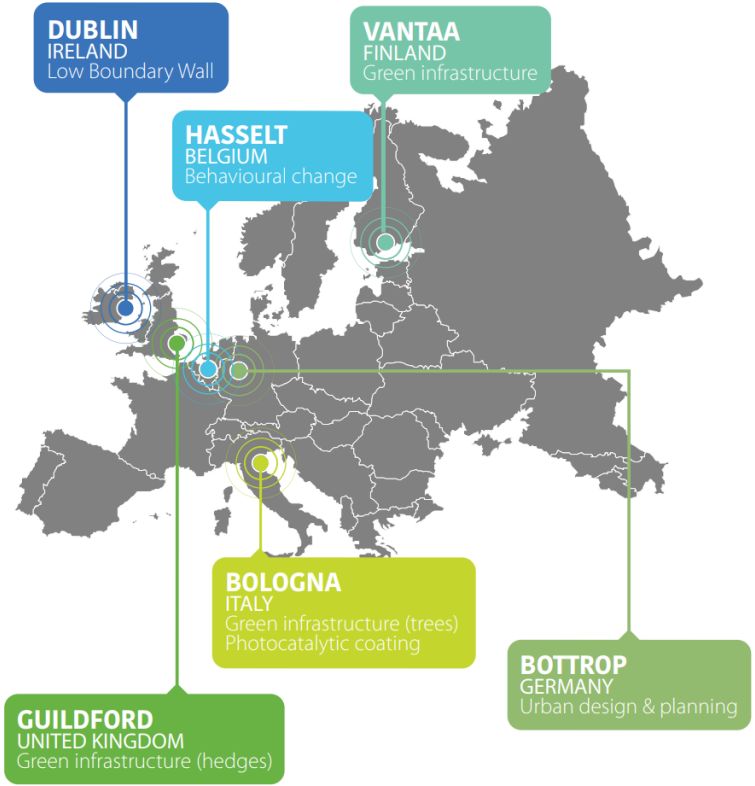
technische universität dortmund

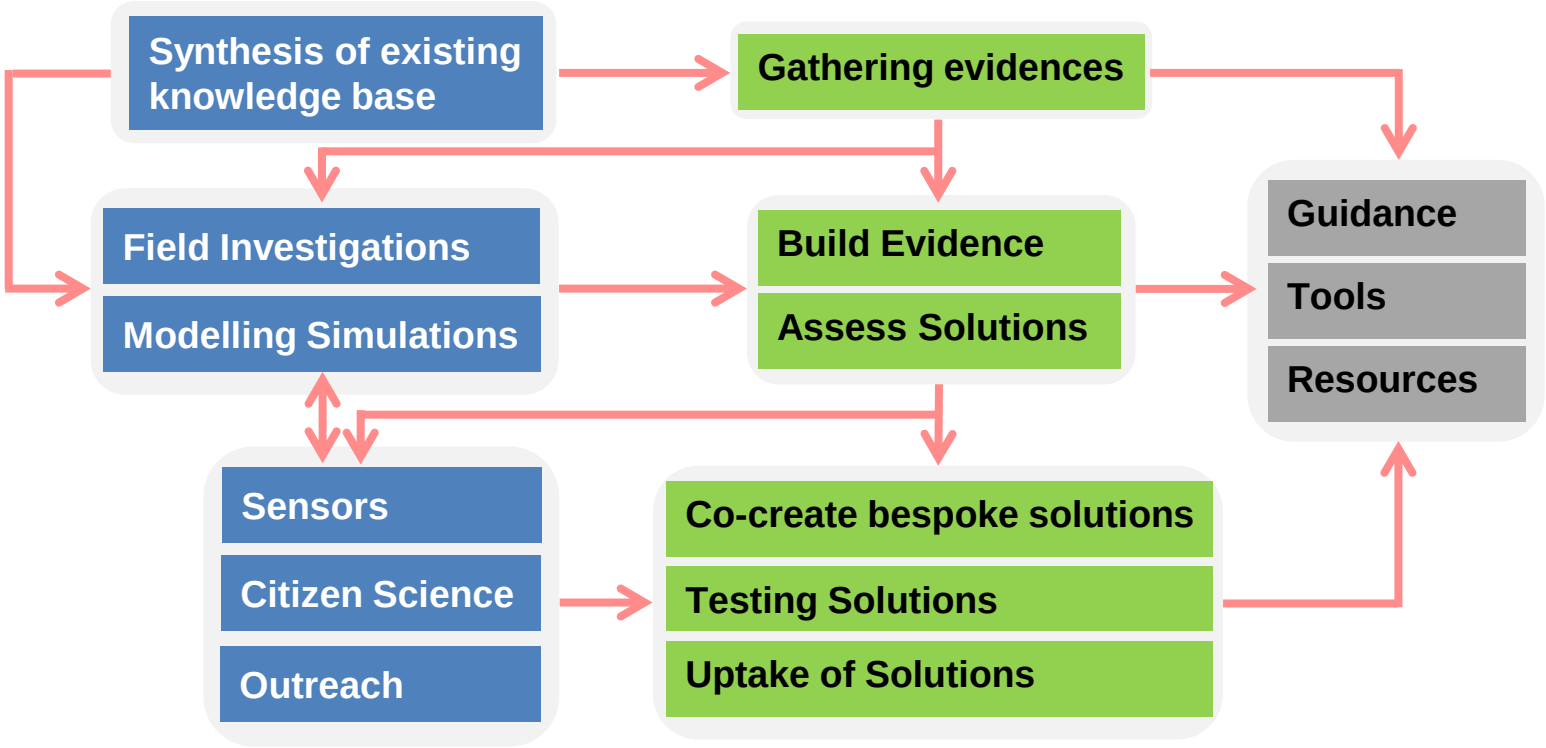
FINNISH METEOROLOGICAL INSTITUTE

iSCAPE Living Labs

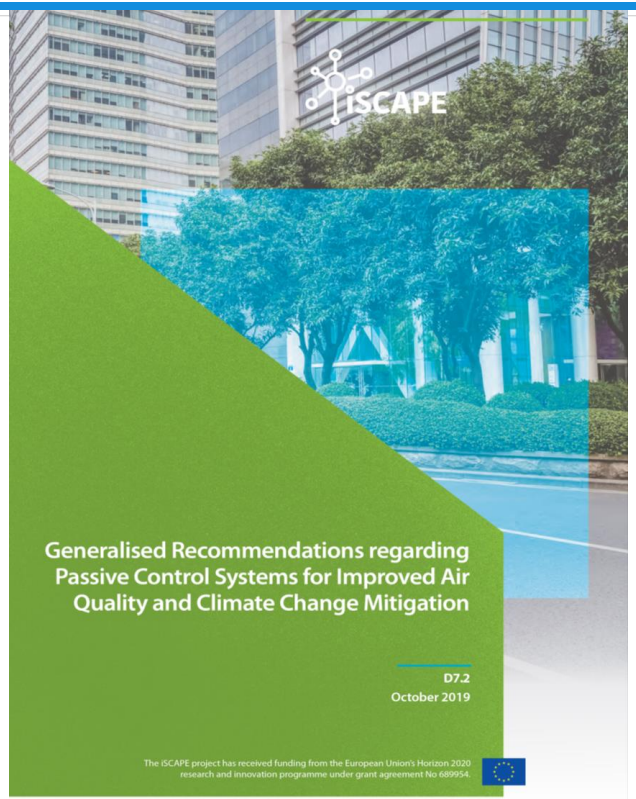


iSCAPE
LivingLabs
Platform

Intervention Evaluation Strategy



Intervention Evaluation Strategy



x6

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iSCAPE Bottrop LivingLab

iSCAPE Bologna LivingLab

iSCAPE Dublin LivingLab

iSCAPE Hasselt LivingLab

iSCAPE Vantaa LivingLab

Stakeholders

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GUILDFORD BOROUGH

iSCAPE Dublin LivingLab

Dublin City Council
Comhairle Cathrach Bhaile Átha Cliath

iSCAPE Bottrop LivingLab

bottrop.

iSCAPE Hasselt LivingLab

HASSELT HEEFT HET.

iSCAPE Bologna LivingLab

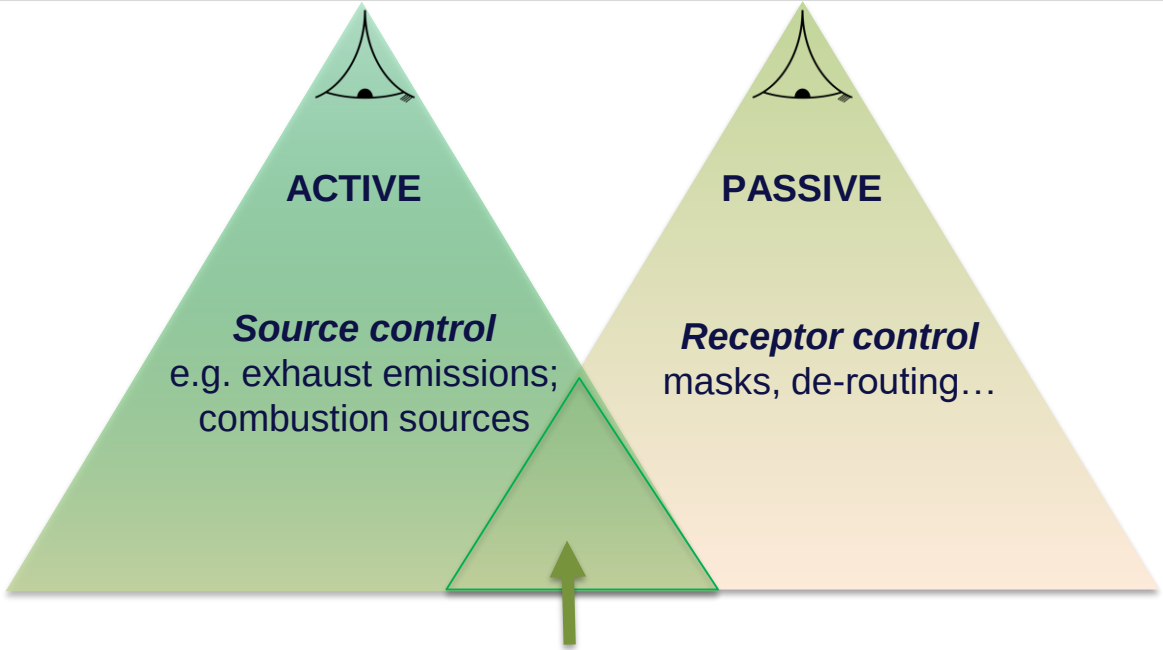
COMUNE DI BOLOGNA

RegioneEmilia-Romagna

iSCAPE Vantaa LivingLab

Vantaa

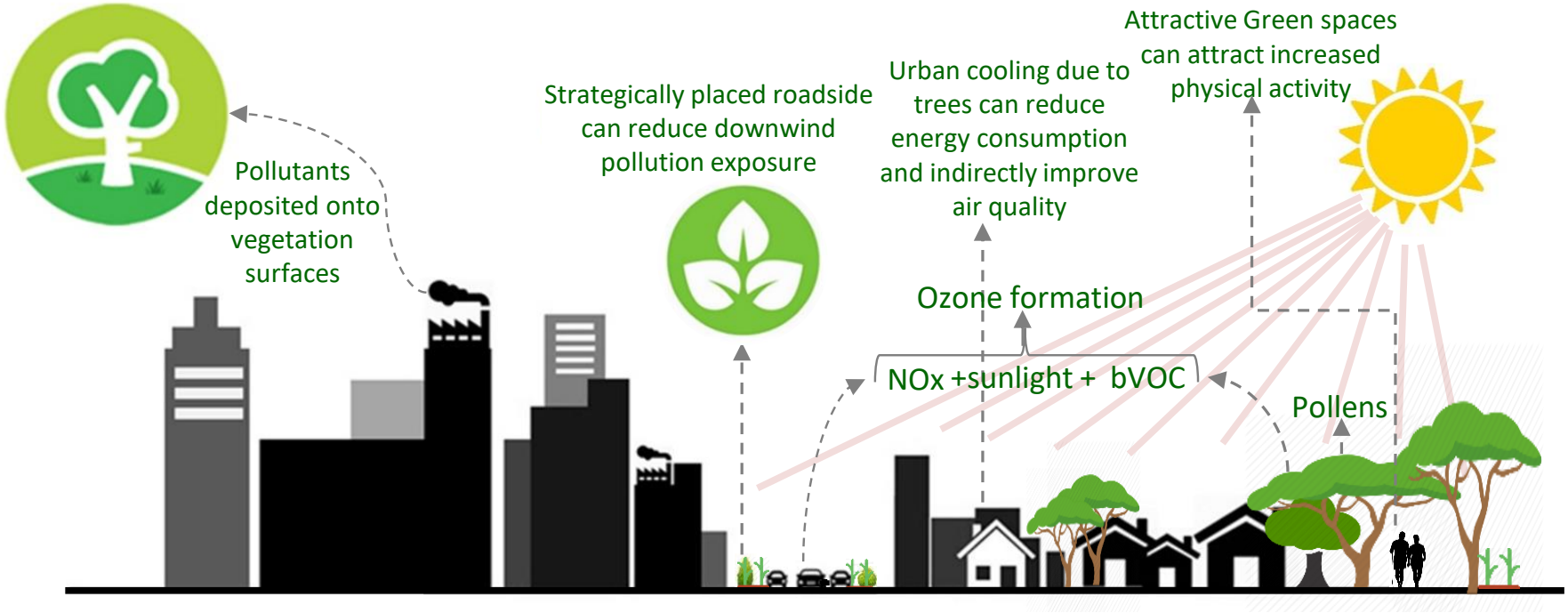
Where Does iSCAPE Interventions Fit?



Between source and receptor

Green barriers; Trees, Green roofs; Green walls; Low-boundary walls; Photocatalytic coating

How Does Greening Works?



Kumar, et al., 2019. *Environment International* 133, 105181.

General Urban Planning

Key Findings and Recommendations

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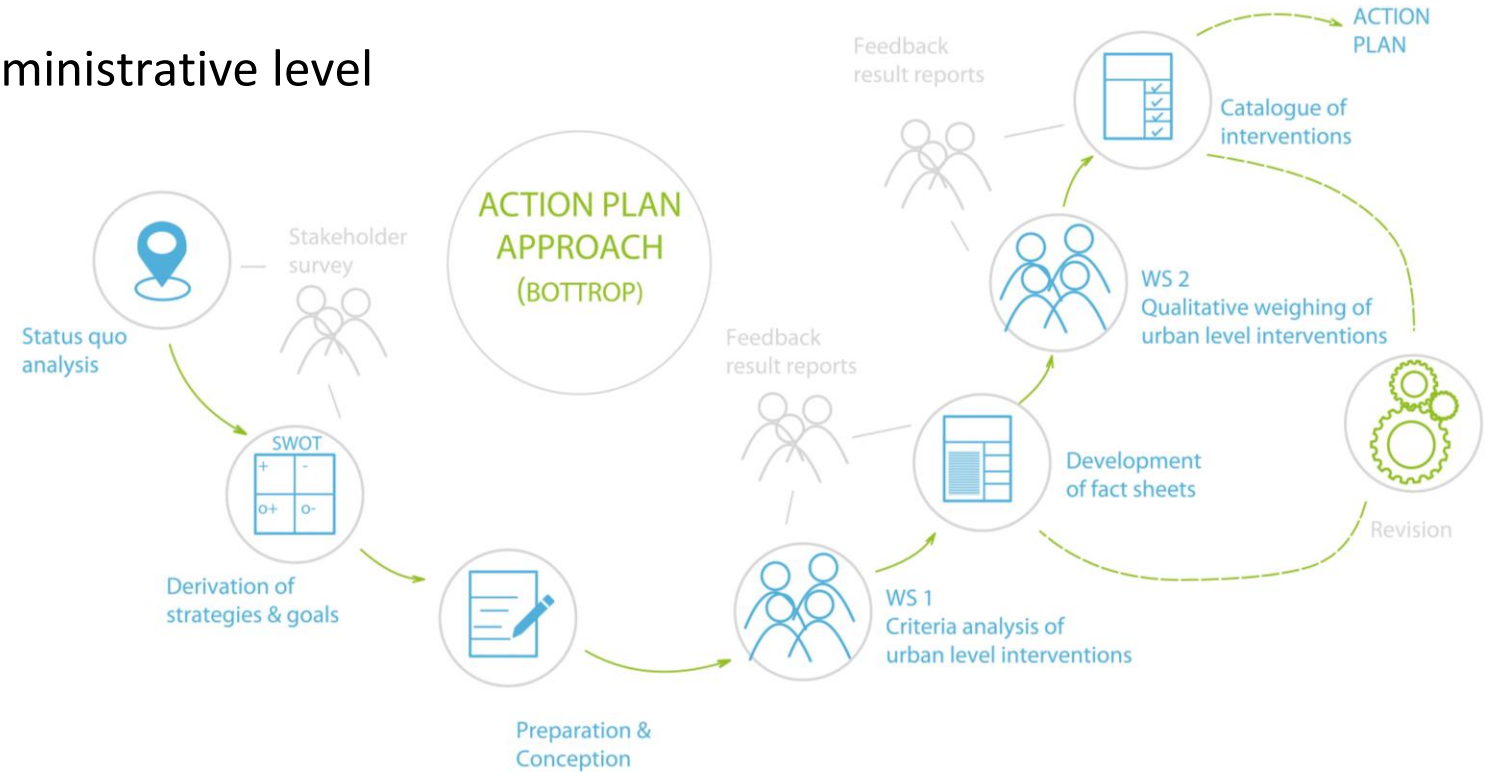
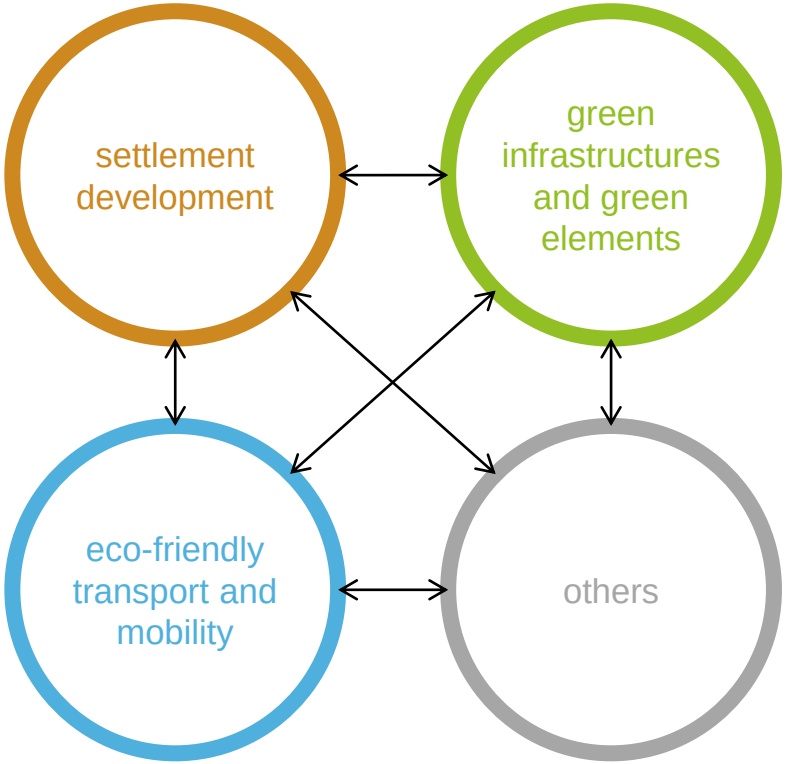
Urban Planning and Development – Action Plan Approach

Administrative level



Urban Planning and Development - Fields of Action

Content level

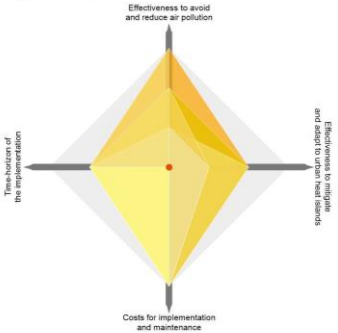


Interactions (synergies or conflicts) & side effects regarding other interests

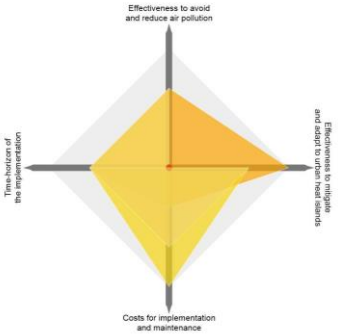
Assessment of Urban Interventions (Workshop 1)

SETTLEMENT DEVELOPMENT

Organisational urban level interventions

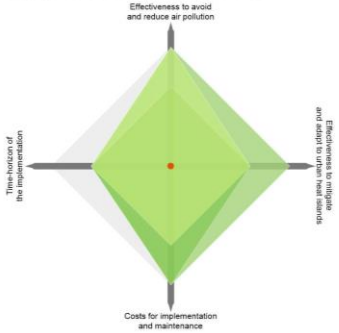


Technical urban level intervention

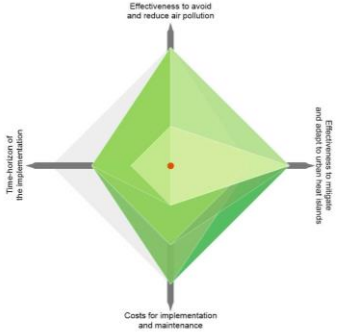


GREEN INFRASTRUCTURES AND GREEN ELEMENTS

Organisational urban level interventions

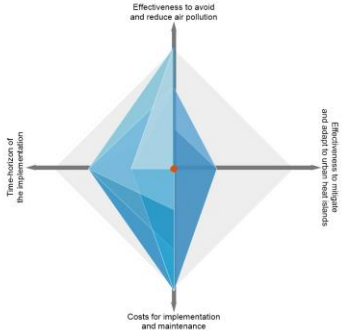


Technical urban level intervention

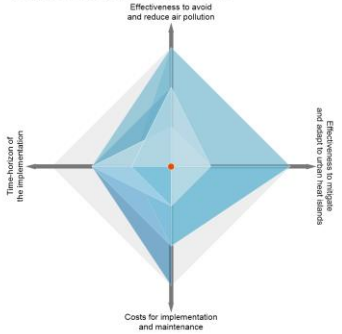


ECO-FRIENDLY TRANSPORT AND MOBILITY

Organisational urban level interventions



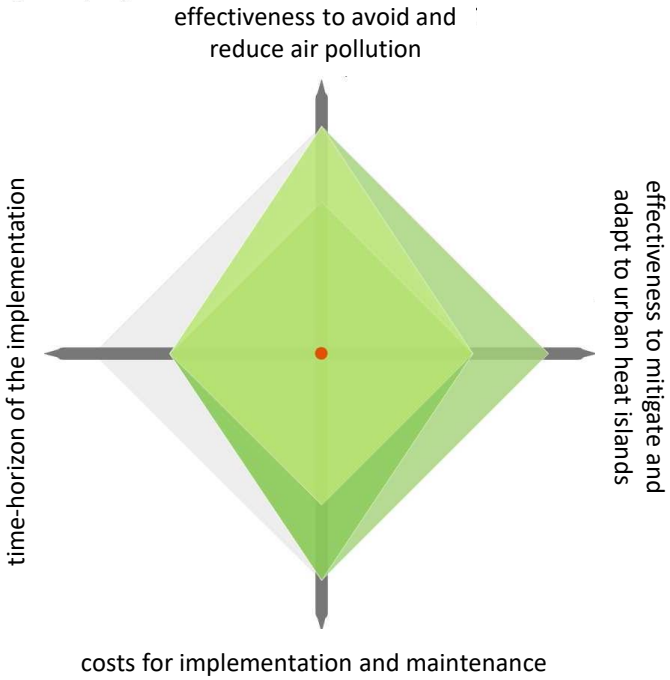
Technical urban level intervention



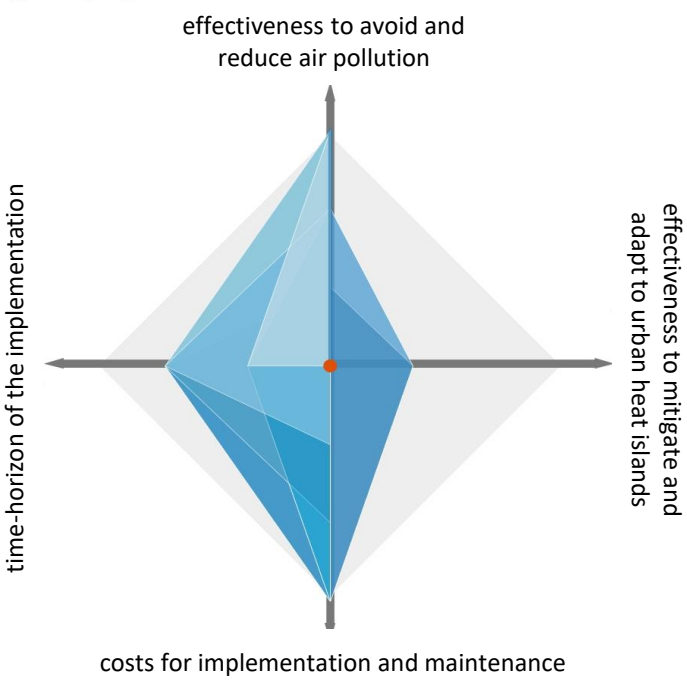
Results of a criteria analysis carried out by an interdisciplinary team of local experts from iSCAPE case city Bottrop, Germany

Assessment of Urban Interventions (Workshop 1)

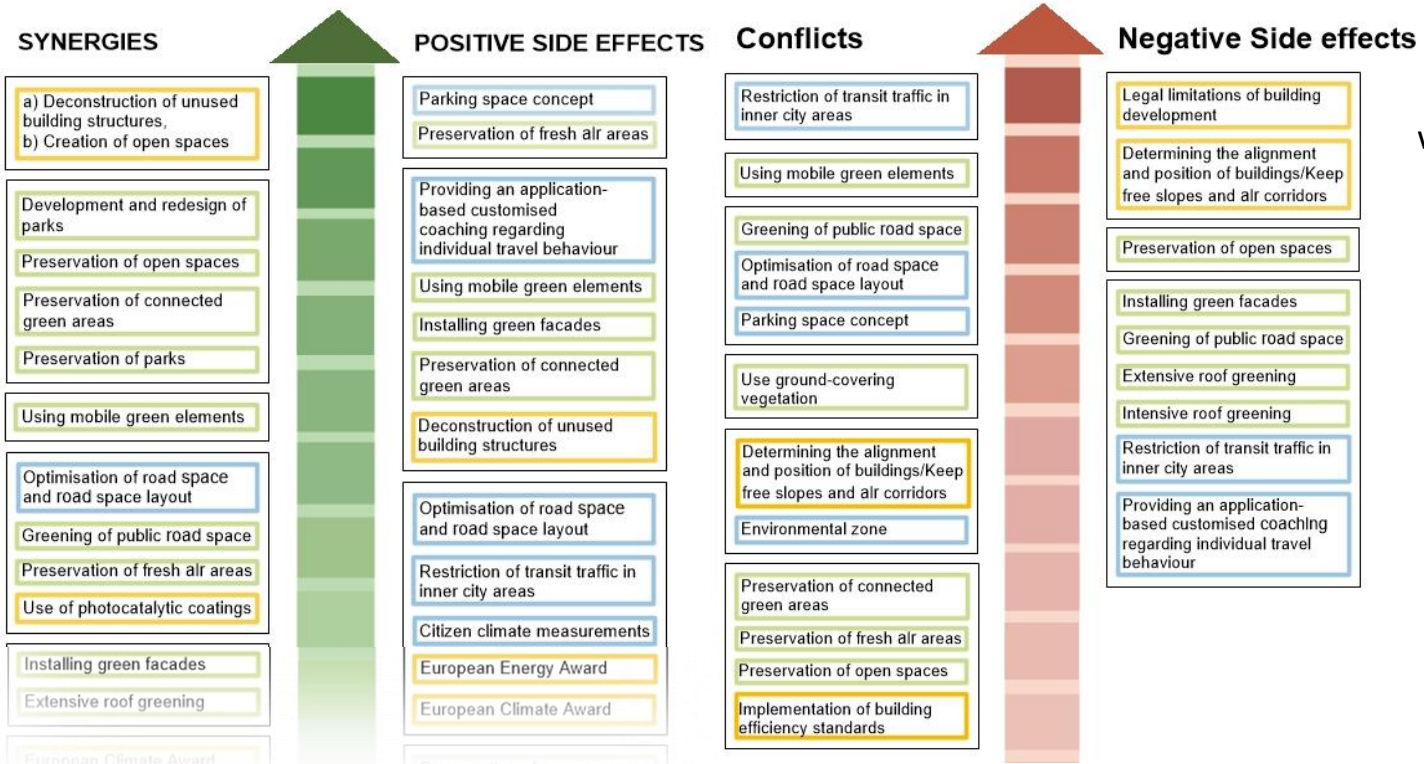
GREEN INFRASTRUCTURES AND GREEN ELEMENTS



ECO-FRIENDLY TRANSPORT AND MOBILITY

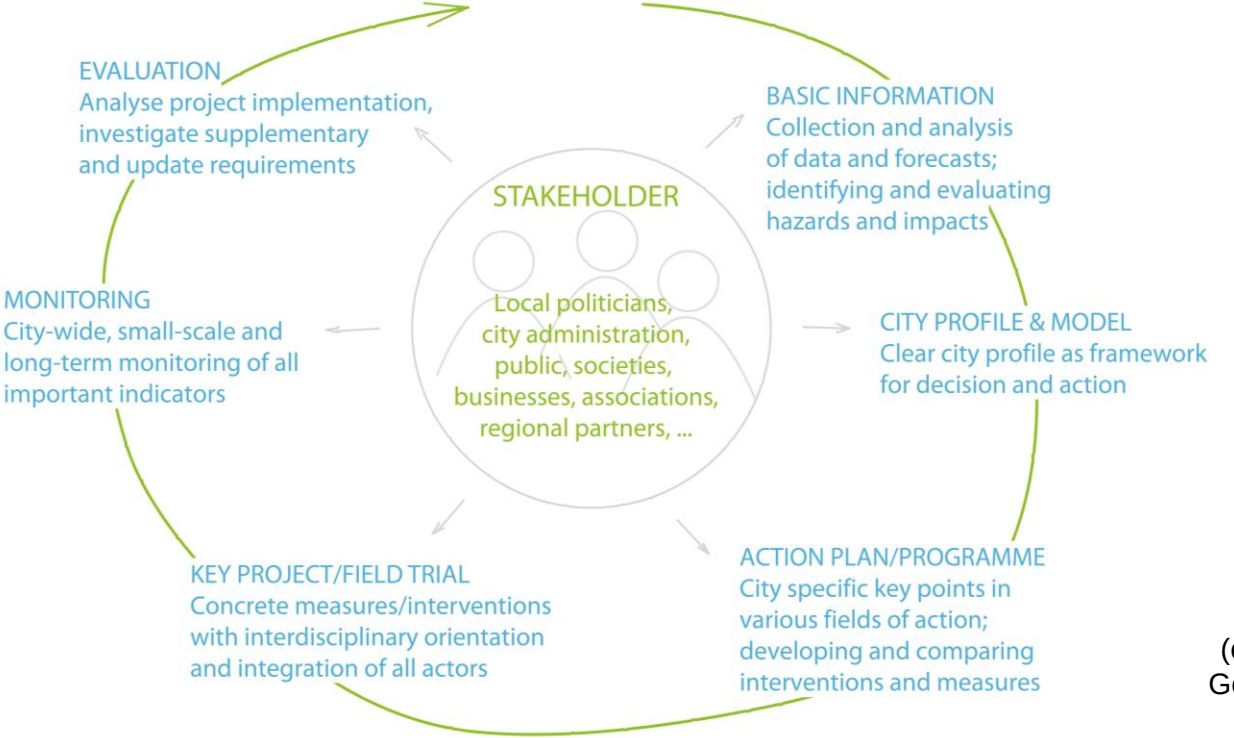


Qualitative Weighing (Workshop 2)



Results of a qualitative weighing carried out by an interdisciplinary team of local experts from iSCAPE case city Bottrop, Germany

Recommendations – Urban Planning



(own figure based on German Association of Cities 2013)

German Association of Cities, 2013. Integrated Urban Development Planning and Urban Development Management – Strategies and instruments for sustainable urban development: Position Paper by the German Association of Cities.

Recommendations – Urban Planning

Conditions and requirements of developing and implementing an action plan effectively:

cooperation & networking

political support

involvement of & acceptance by citizens

personnel resources, financing & subsidies

implementation strategy

integrating in existing implementation instruments & tools

monitoring & evaluation

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Open-Road and Street Canyons Trees and Hedges

Key Findings and Recommendations

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Building Research Foundation

Abhijith, Kumar, et al., 2017. *Atmospheric Environment* 162, 71-86.

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BBC Sign in News Sport Weather iPlayer Sounds

Open road

Street canyon

ELSEVIER

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Review article

Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments – A review

K.V. Abhijith [a], Prashant Kumar [a, b, *], John Gallagher [c, d], Aonghus McNabola [c], Richard Baldauf [e, f], Francesco Pilla [g], Brian Broderick [c], Silvana Di Sabatino [h], Beatrice Pulvirenti [i]

Deterioration Improvement NA for Air Quality

Abhijith, Kumar, et al., 2017. *Atmospheric Environment* 162, 71-86.

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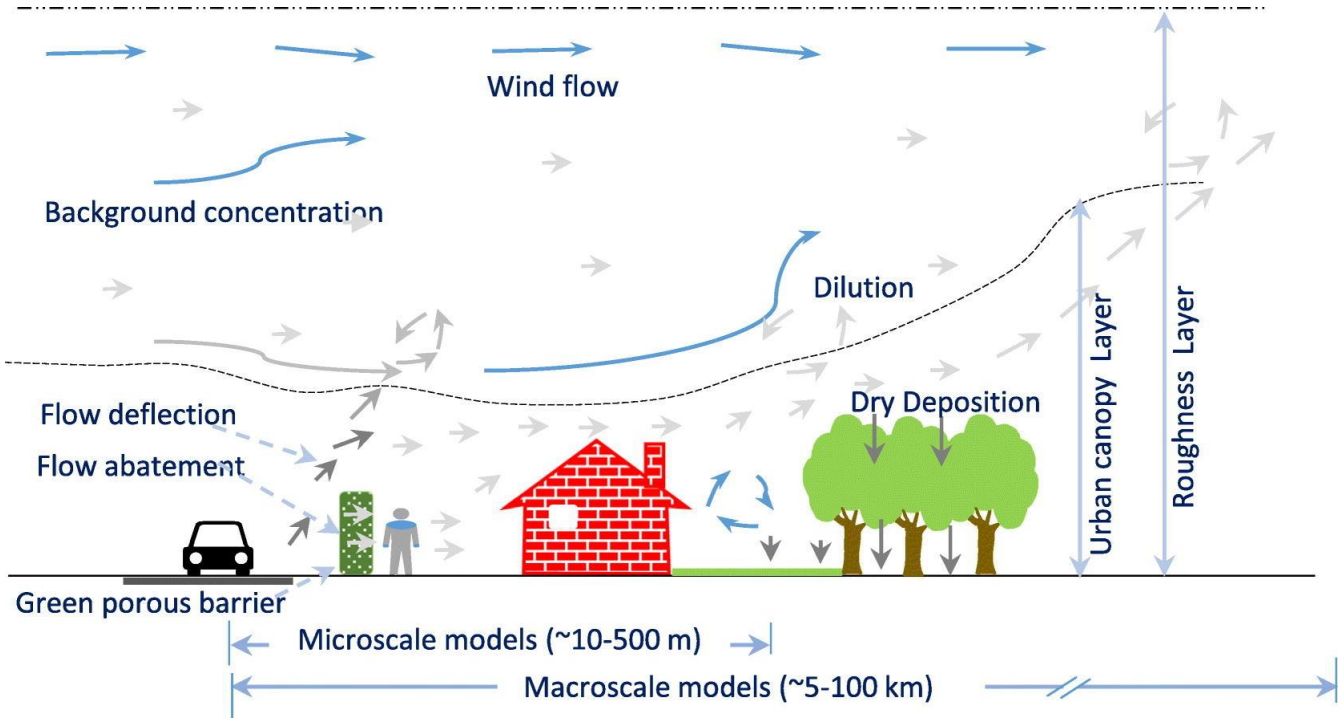

Tiwari, Kumar, et al., 2019. *Science of The Total Environment* 672, 410-426

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Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Review

Considerations for evaluating green infrastructure impacts in microscale and macroscale air pollution dispersion models

Arvind Tiwari [a], Prashant Kumar [a,b,*], Richard Baldauf [c,d], K. Max Zhang [e], Francesco Pilla [f], Silvana Di Sabatino [g], Erika Brattich [g], Beatrice Pulvirenti [h]

Macroscale models (~5-100 km)

Tiwari, Kumar, et al., 2019. *Science of The Total Environment* 672, 410-426

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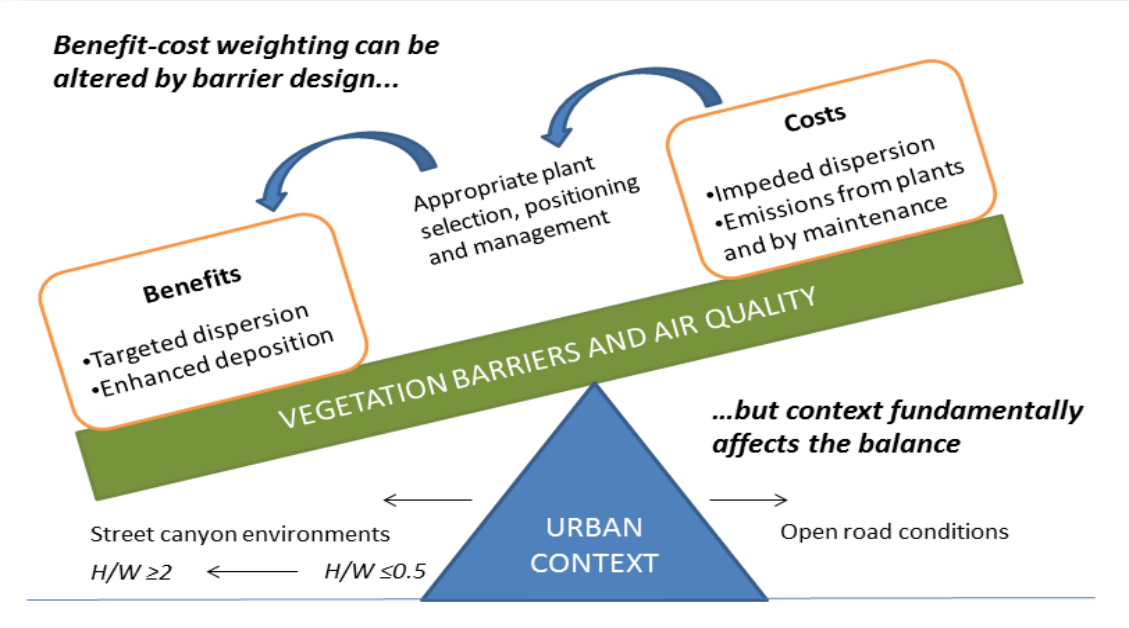
Proven air pollution tolerance index, low pollen and bVOC emissions



Barwise & Kumar, 2019. *npj Climate and Atmospheric Science (under review).*

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Proven air pollution tolerance index, low pollen and bVOC emissions

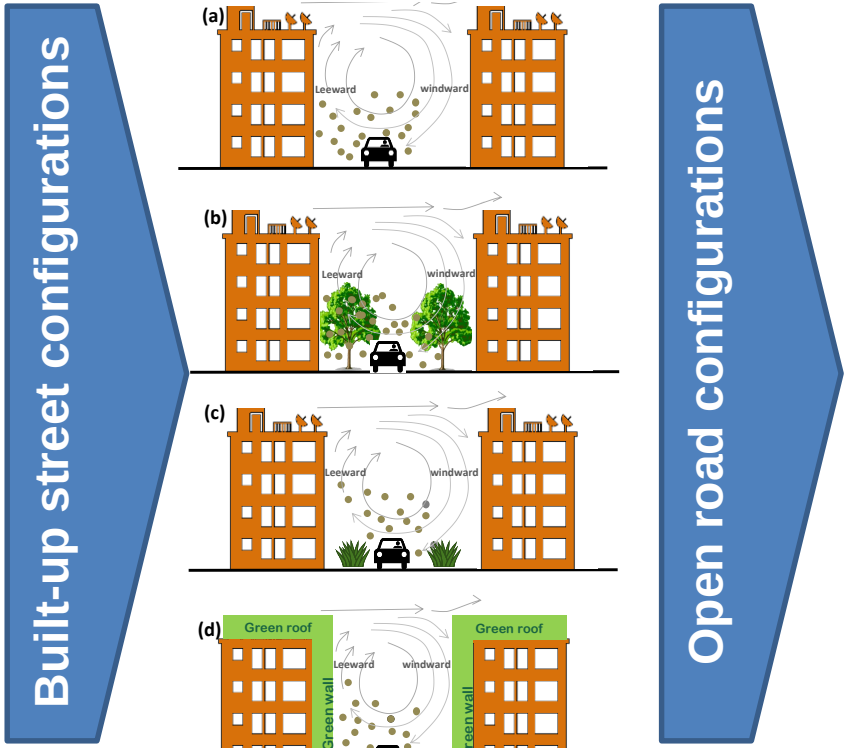
Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection

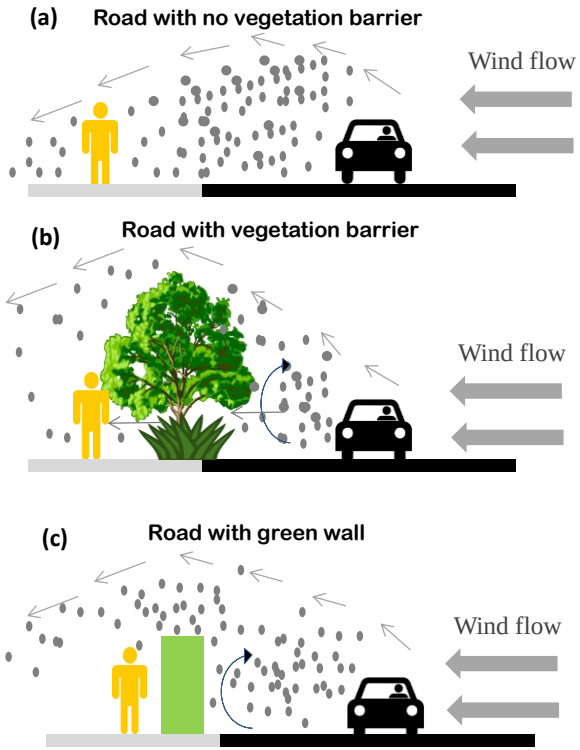
Yendle Barwise, Prashant Kumar [1]

Global Centre for Clean Air Research (GCARE), Department of Civil and Environmental Engineering, Faculty of Engineering and Physical Sciences, University of Surrey, Guildford GU2 7XH, United Kingdom

Barwise & Kumar, 2019. *npj Climate and Atmospheric Science (under review).*

Street v/s Open Roads



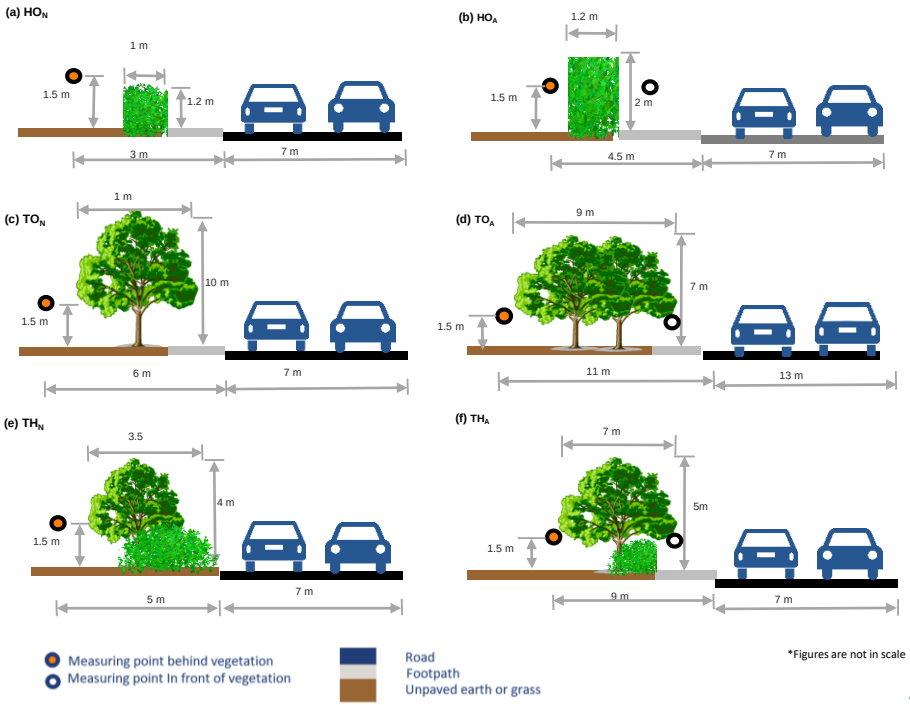


Abhijith, Kumar, et al., 2017. *Atmospheric Environment* 162, 71-86.

Open-Road Scenarios

Near-road scenario (<1m)

Far-road scenario (>2m)



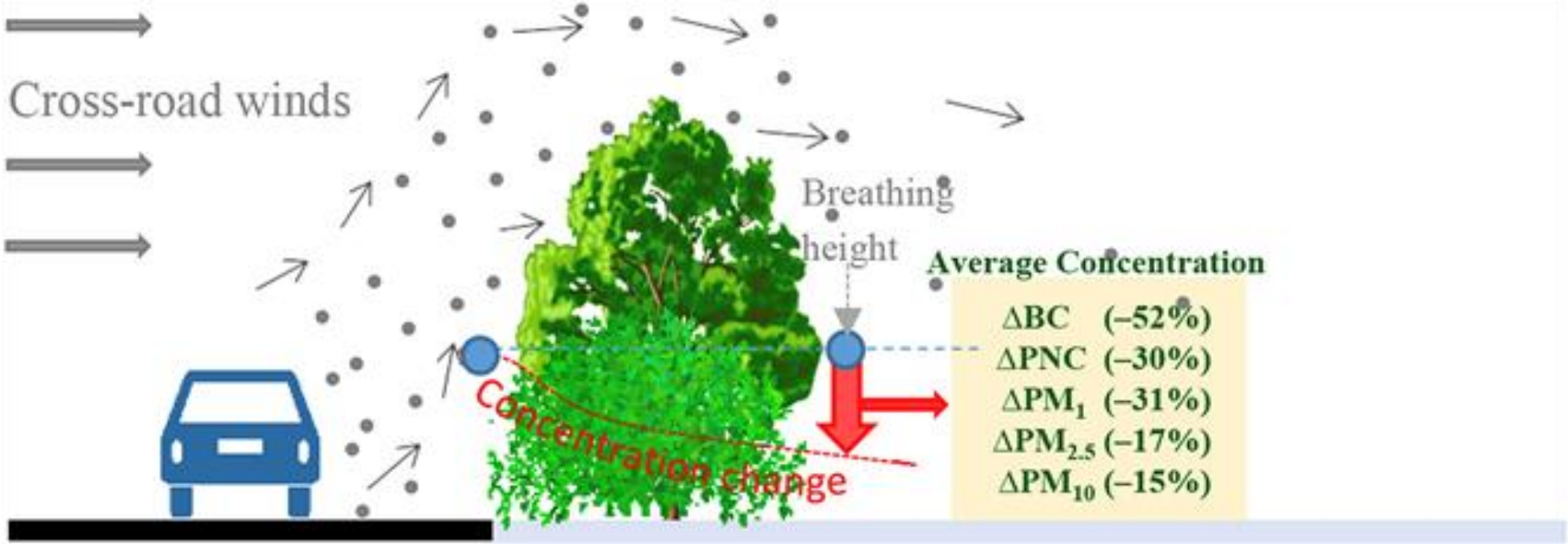
*Figures are not in scale

Instruments on tripod

Abhijith & Kumar, 2019. *Atmospheric Environment* 201, 132-147.

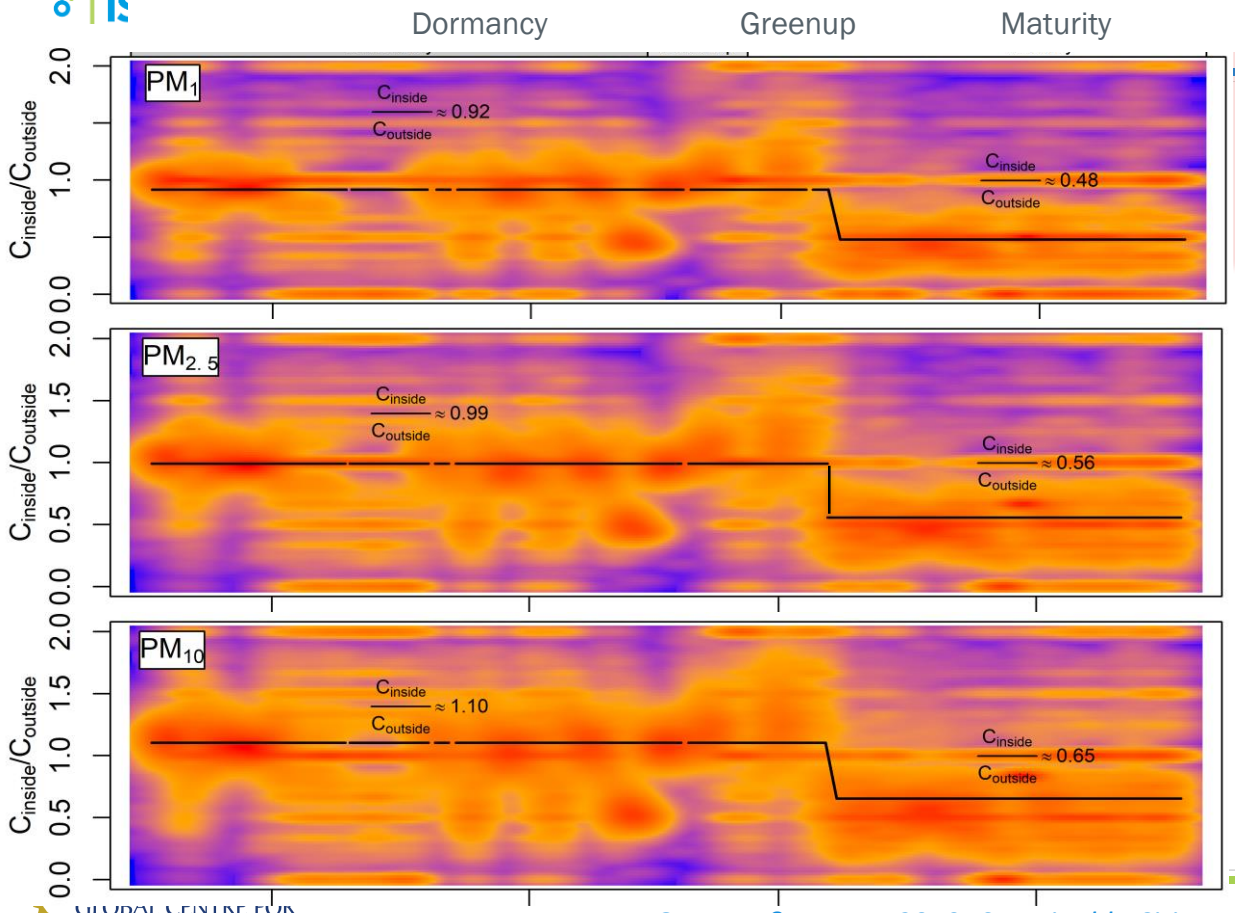
Open-Road Findings

Average concentration change: Along-road > Cross-road > Cross-Vegetation



Abhijith & Kumar, 2019. *Atmospheric Environment* 201, 132-147.

For the first time..



LAI <2.9
Dormancy

LAI > 2.93
Greenup

LAI ~7-8
Greenup

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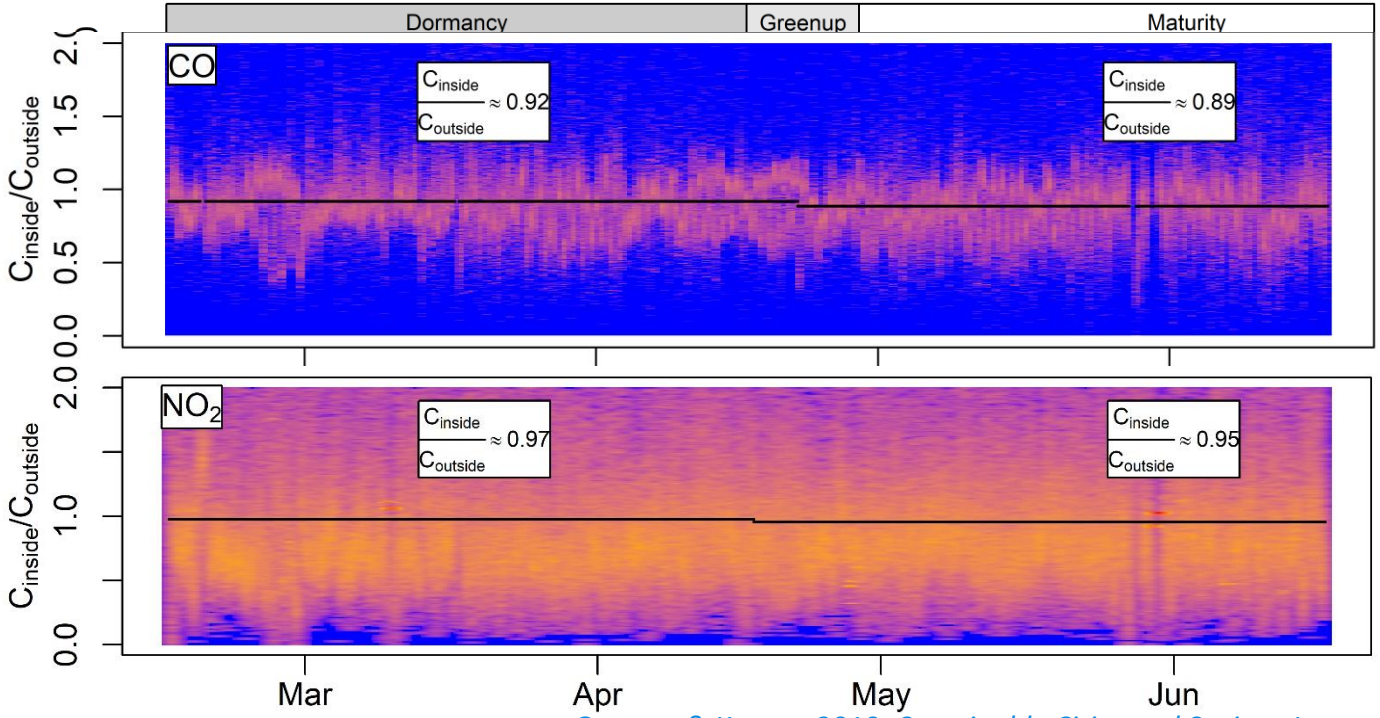
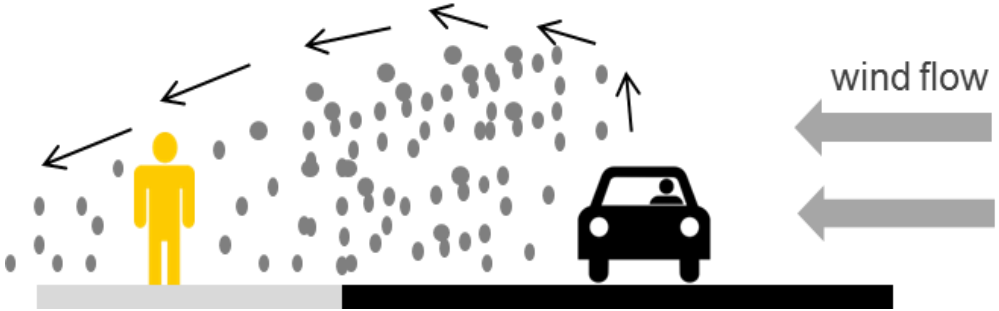
Ottosen & Kumar, 2019. *Sustainable Cities and Society*. In press.

Guildford field campaign

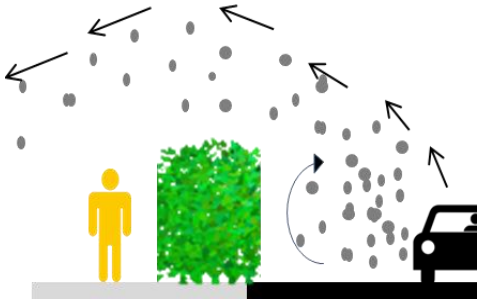


Ottosen & Kumar, 2019. *Sustainable Cities and Society*. In press.

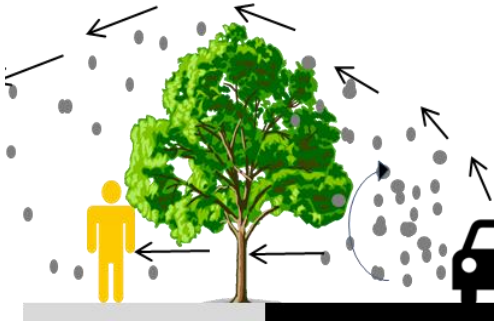
Open-Road Recommendations



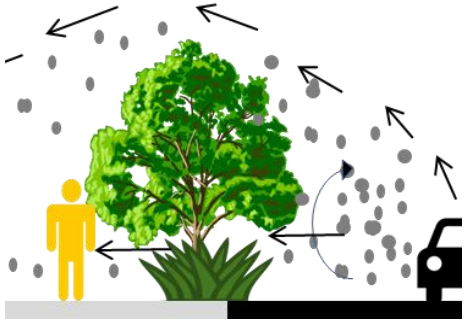
Hedge ★★★★



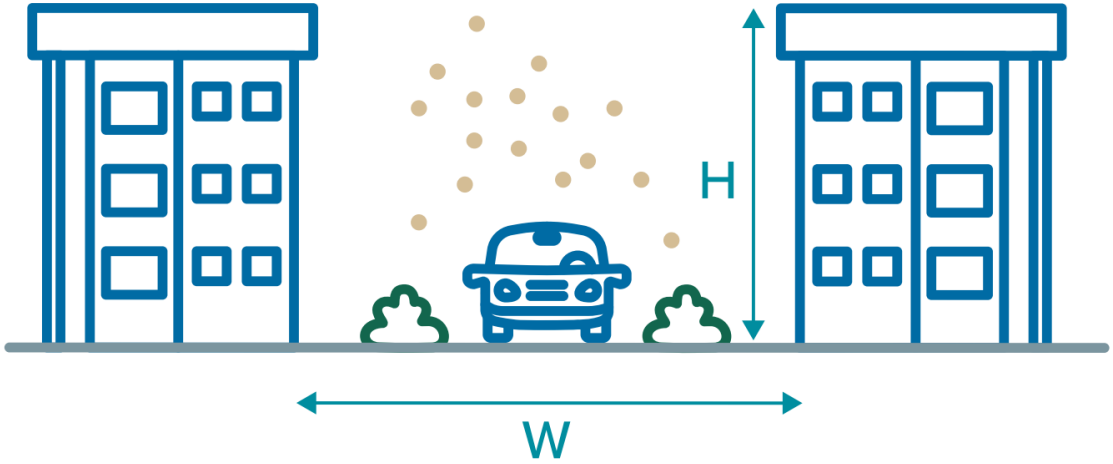
Trees ★★



Tree + Hedge ★★★★★

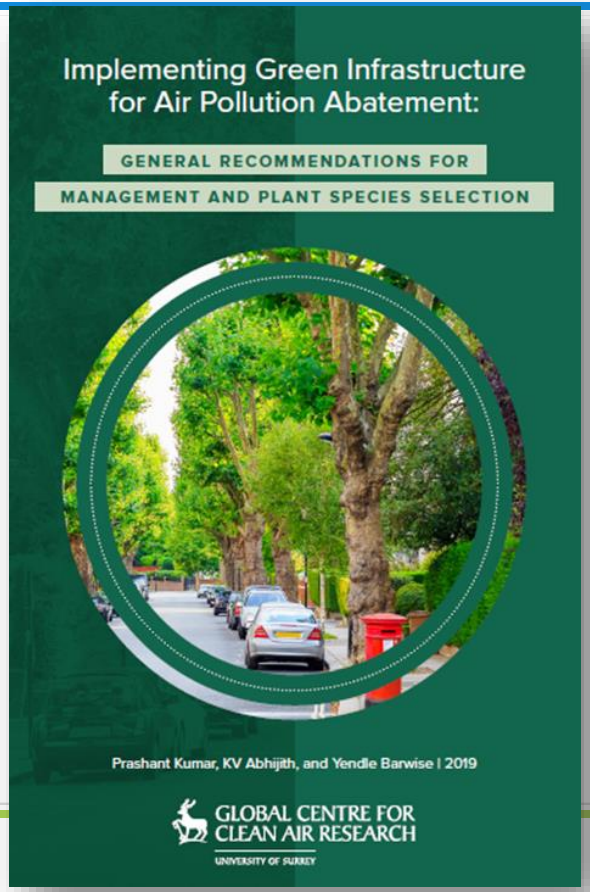


Street Canyon Recommendation



***H/W* ≤ 0.5**	**0.5 < *H/W* < 2**	***H/W* ≥ 2**
wide street canyons	street canyon	deep street canyons
Trees ⊘	Trees ⊘	Trees ⊘
Hedges ✓	*Hedges* ✓	*Hedges* ⊘
Green walls ✓	*Green walls* ✓	*Green walls* ✓

Transforming Complex Science into Guidance ...

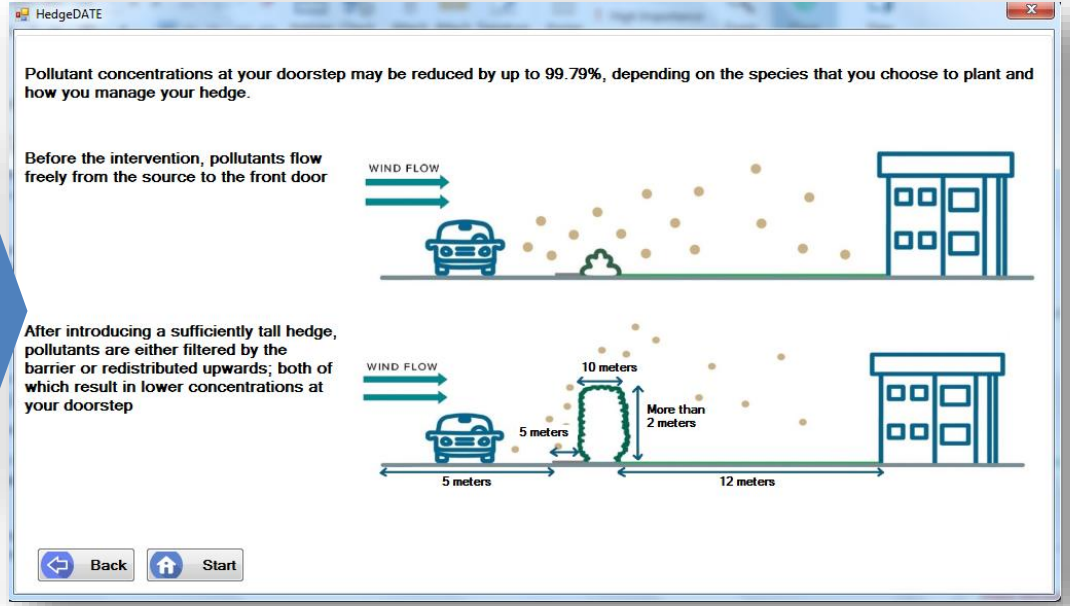


Co-created ideas from conception to public use

Further a need for simple tool that people can allow people design their hedges emerged from those events……

HedgeDATE

Hedge Design for Abatement of Traffic Emissions



Barwise, Kumar, et al., (2019). *In preparation.*

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Trees in Urban Street Canyons

Key Findings and Recommendations

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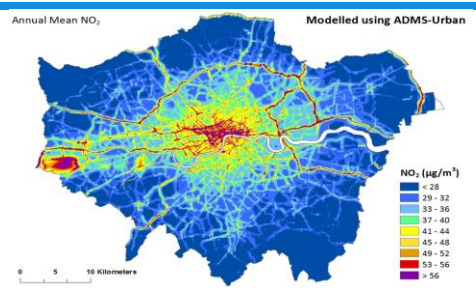
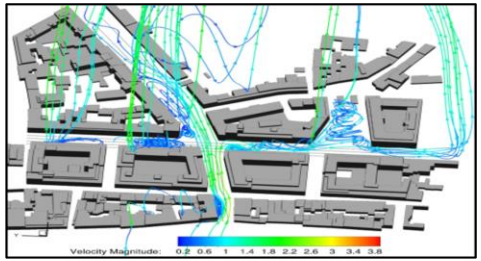
Multi-Scale & Multi-Approach Methodology



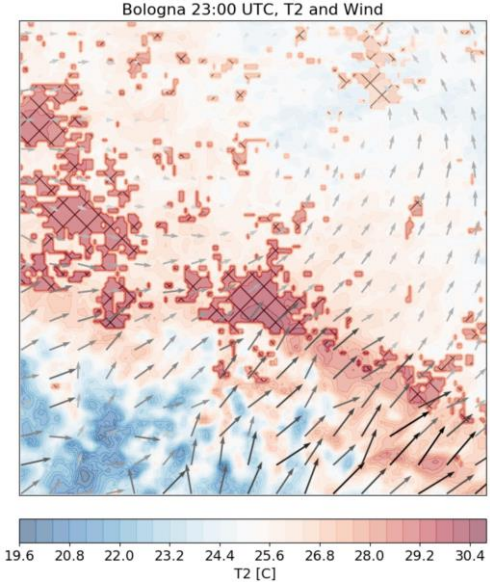
ADMS Simulations



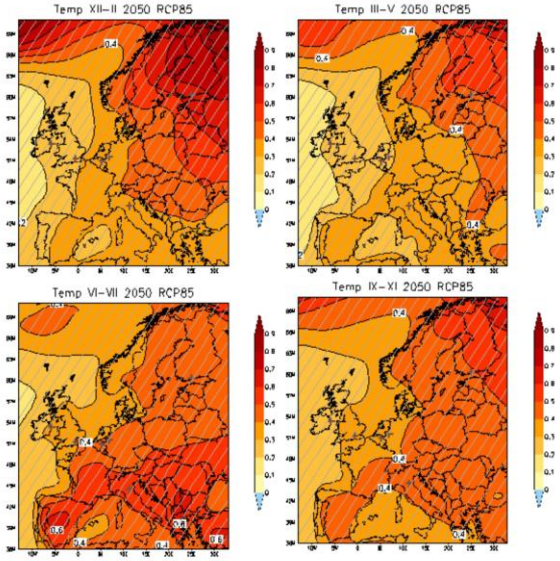
CFD Simulations

Pilots in real environment

WRF Simulations



Climate change

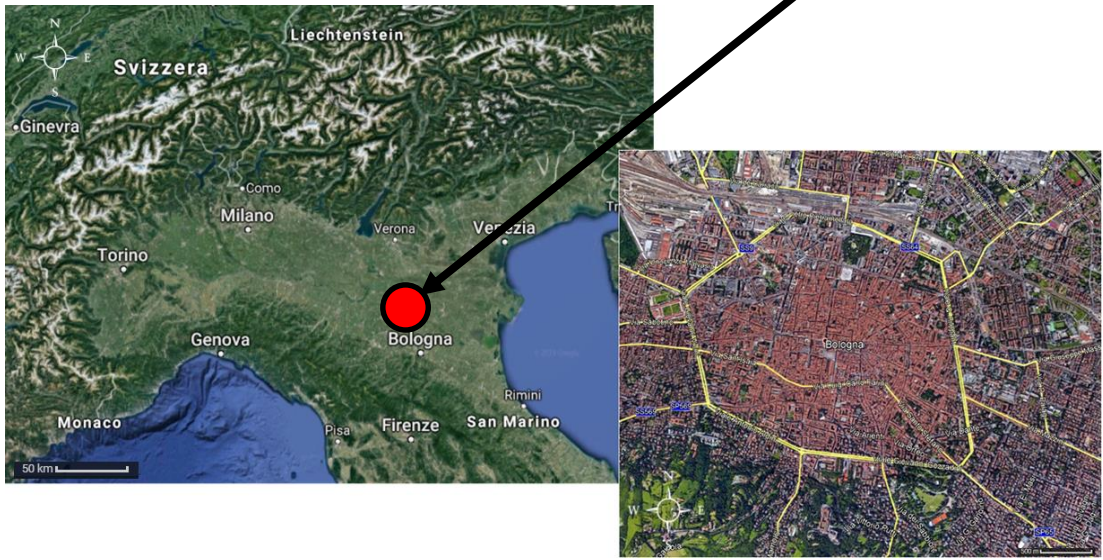


Trees in Urban Street Canyons: The Bologna Experimental Field Campaigns

2 experimental campaigns

Role of **vegetation** in altering **ventilation** and **thermal comfort** in urban street canyons, and how this relates to **pollutant concentrations**

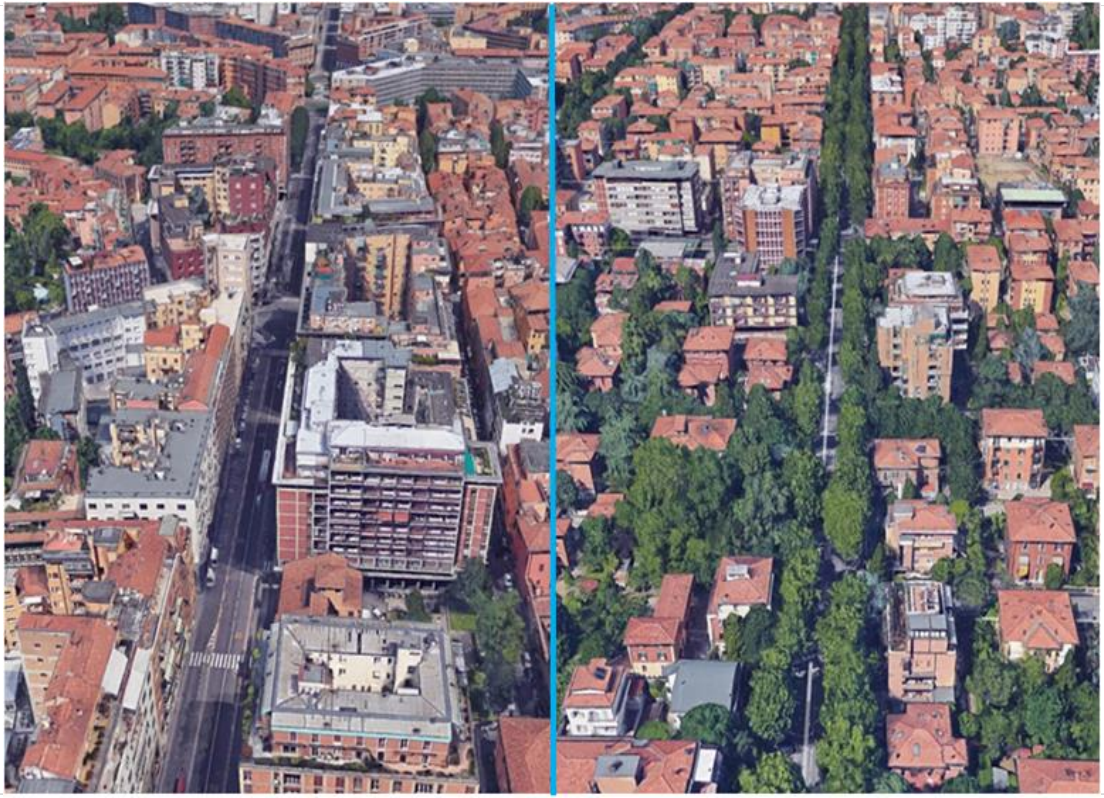
BOLOGNA



Trees in Urban Street Canyons: The Bologna Experimental Field Campaigns

Marconi Street

NO TREES



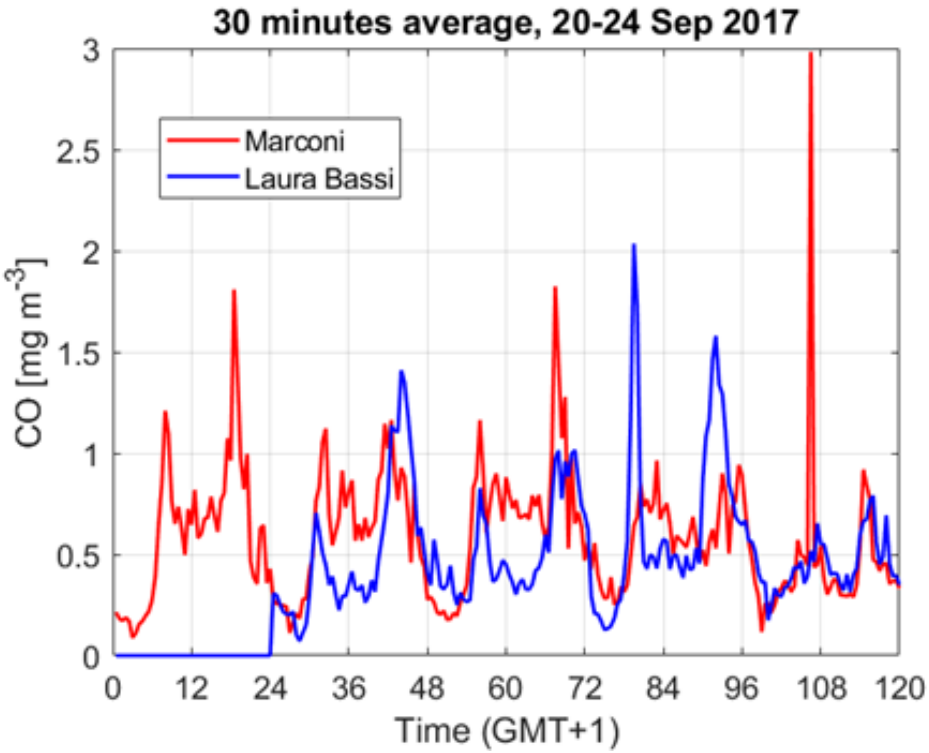
Laura Bassi Street

TREES

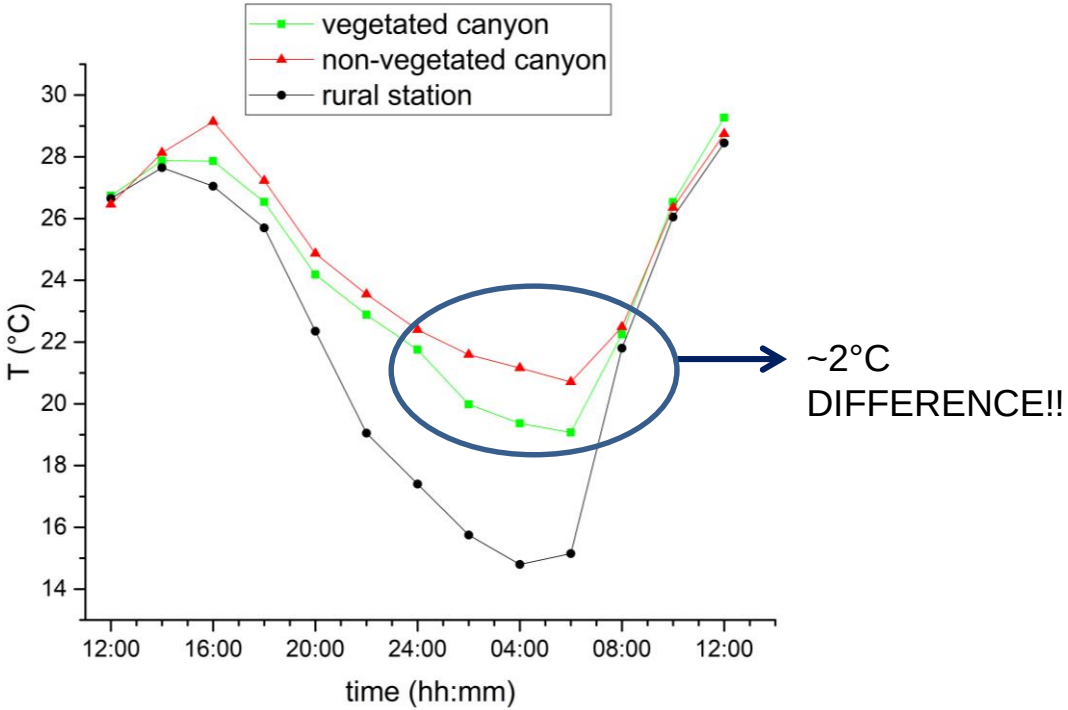
Trees in Urban Street Canyons: Air Quality

Pollutant concentrations inside the street canyon are mainly affected by:

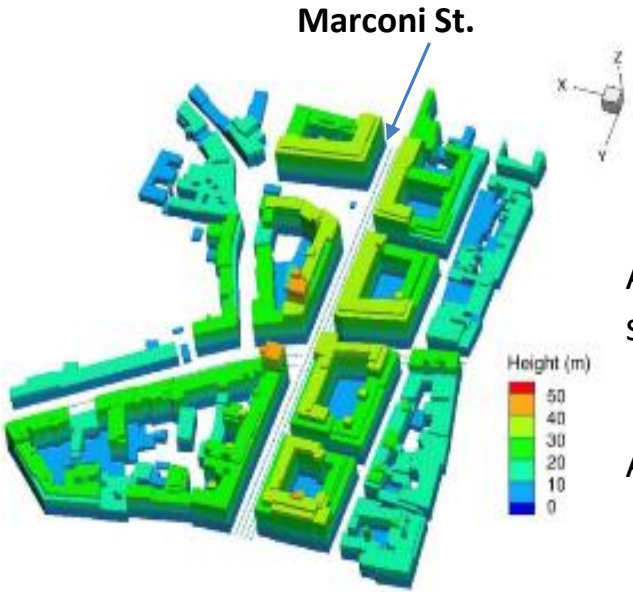
- **Traffic** volume, type and emissions
- Street canyon **aspect ratio**
- Vicinity of multiple sources



Trees in Urban Street Canyons: Urban Thermal Comfort



Trees in Urban Street Canyons: CFD Simulations



Average concentration on a section: 0.87 mg m^{-3}

Air temperature: 26.9°C

Trees in Urban Street Canyons: CFD Simulations

Populus tremula
LAD: 2.03 m^2 m^{-3}

Fagus sylvatica
LAD: 0.97 m^2 m^{-3}

Trees in Urban Street Canyons: CFD Simulations

1 High LAD – 3.5m

2 High LAD – 1.75m

3 Low LAD – 7m

4 Low LAD – 3.5m

5 Low LAD – 1.75m

Trees in Urban Street Canyons: CFD Simulations

1 High LAD – 3.5m
Average on a section:
0.58 mg m^{-3}

2 High LAD– 1.75m
Average on a section:
0.52 mg m^{-3}

3 Low LAD – 7m
Average on a section:
0.62 mg m^{-3}

4 Low LAD – 3.5m
Average on a section:
0.64 mg m^{-3}

5 Low LAD – 1.75m
Average on a section:
0.63 mg m^{-3}

Trees in Urban Street Canyons: CFD Simulations

1 High LAD – 3.5m
Air temperature: 26.6°C

2 High LAD– 1.75m
Air temperature: 26.5°C

3 Low LAD – 7m
Air temperature: 26.5°C

4 Low LAD – 3.5m
Air temperature: 26.4°C

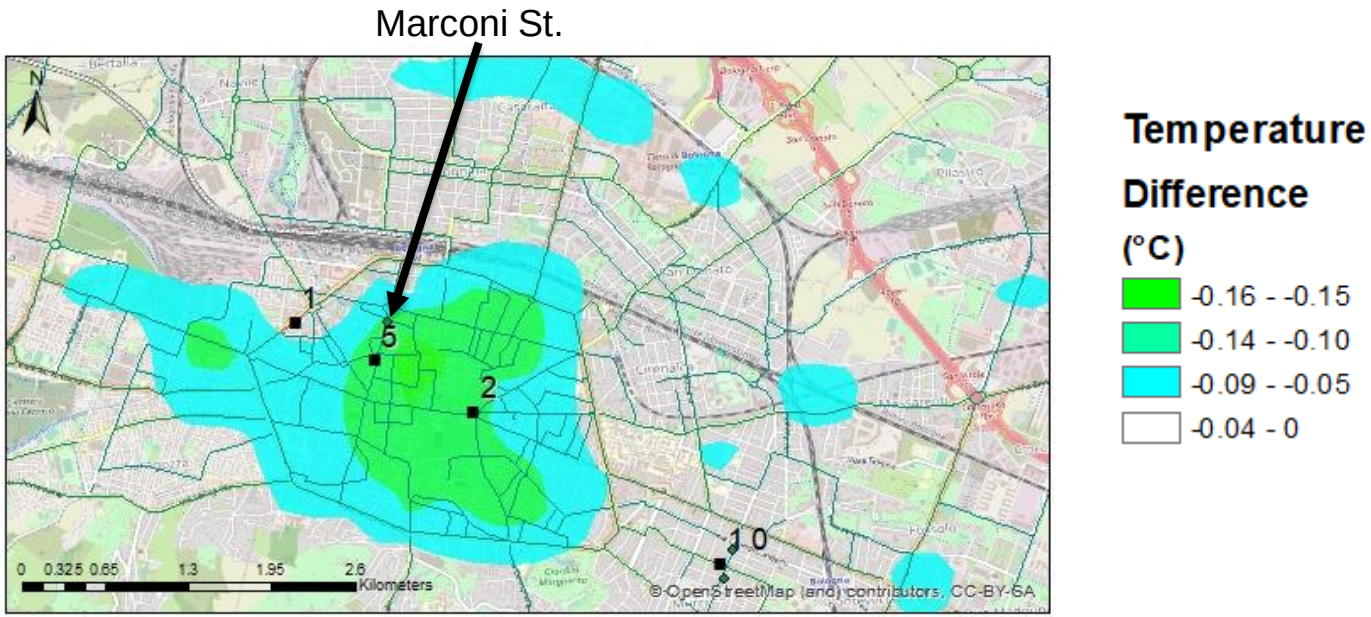
5 Low LAD – 1.75m
Air temperature: 26.4°C

Trees in Urban Street Canyons: CFD Simulations

	Average on a section at pedestrian height (1.5 m)	Average on canyon volume	Local temperature
Baseline configuration CFD	0.87	0.73	26.9
First scenario	0.58	0.48	26.6
Second scenario	0.52	0.41	26.5
Third scenario	0.61	0.52	26.5
Fourth scenario	0.64	0.57	26.4
Fifth scenario	0.63	0.55	26.4

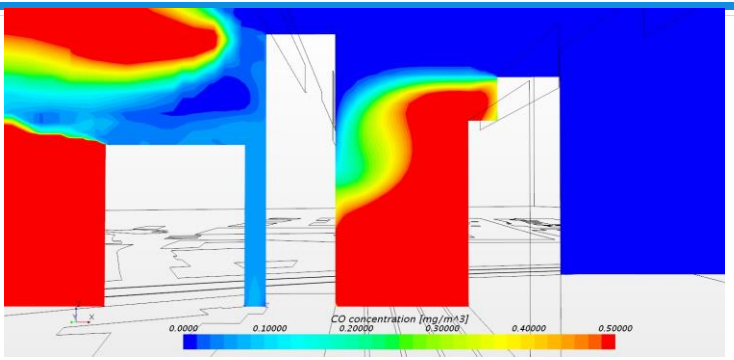
- Trees with **smaller crown** and **higher LAD** give the **lowest averaged** pollutant concentrations
- Trees with **larger crowns** give **lower air temperature**

Trees in Urban Street Canyons: ADMS-TH Simulations

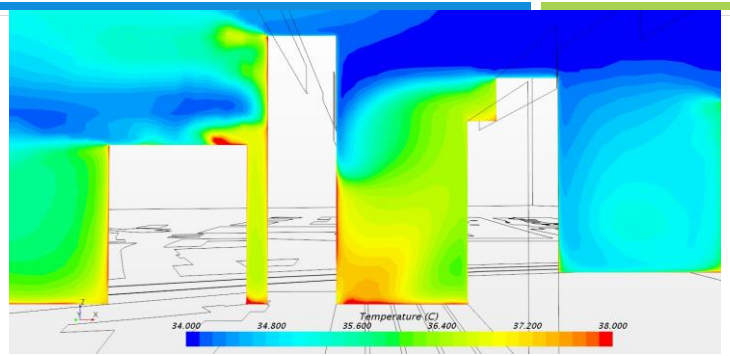


The impact of adding trees over air temperature extends over **larger areas than that of the intervention**!

Trees in Urban Street Canyons: Effects in the Future Scenario



Without trees

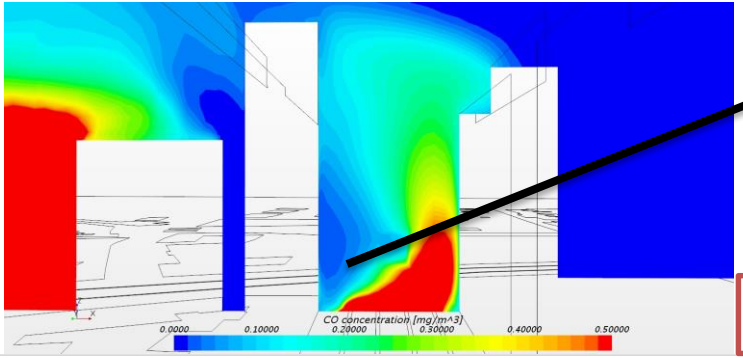


Pollutant concentration

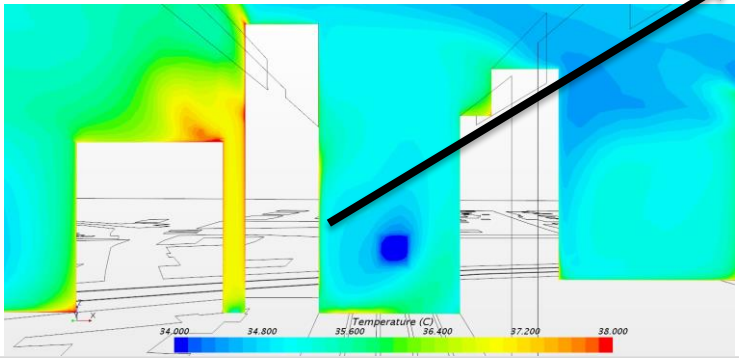
Air temperature

≈ 2°C reduction

≈ 0.3 mg m^{-3}
(40%) reduction



With trees

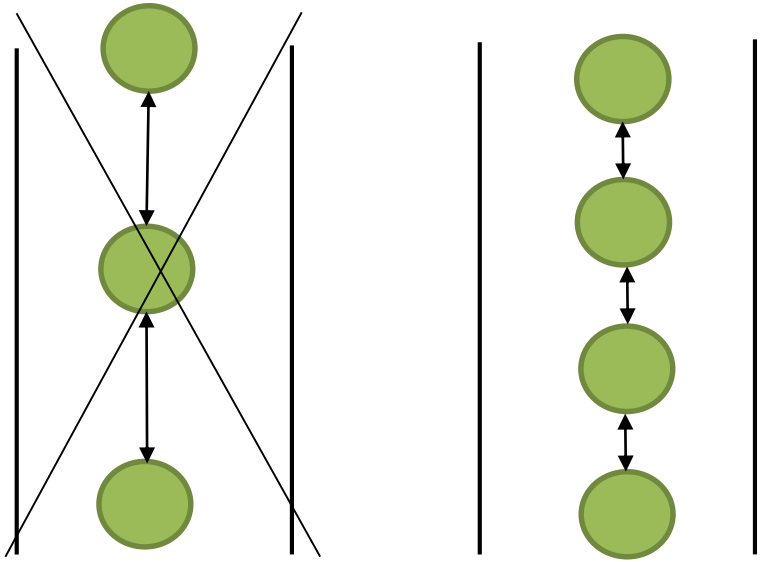


Trees in Urban Street Canyons: Conclusions

- Inserting trees is a **win-win approach**:
  - **lower average distribution** of **pollutants** along the street canyons and local pollutant **hotspots**
  - **improved thermal comfort, also over surrounding neighborhoods**
- **Smaller crowns** and **higher LADs** = **lowest** pollutant **concentrations**.
- **Larger crowns** = highest reduction on **air temperature**
- **Both positive impacts** are **maintained** in the **future** climate scenario

Recommendations: Trees in Urban Street Canyons

DISTANCE



Better to decrease the distance between crowns

LEAF AREA DENSITY

Fagus sylvatica

Lower LAD for air quality improvement

Populus tremula

Higher LAD for urban thermal comfort

iSCAPE

Photocatalytic Coatings

Key Findings and Recommendations

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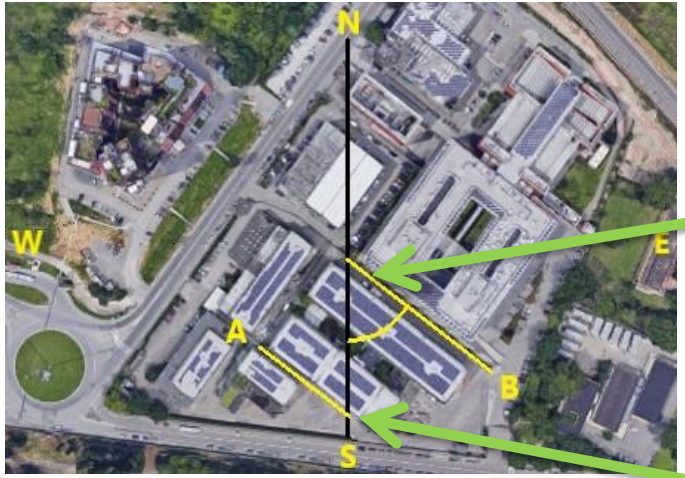
Photocatalytic Coatings

Experimental field campaign in a neighborhood of the Municipality of **Bologna** located outside the city center

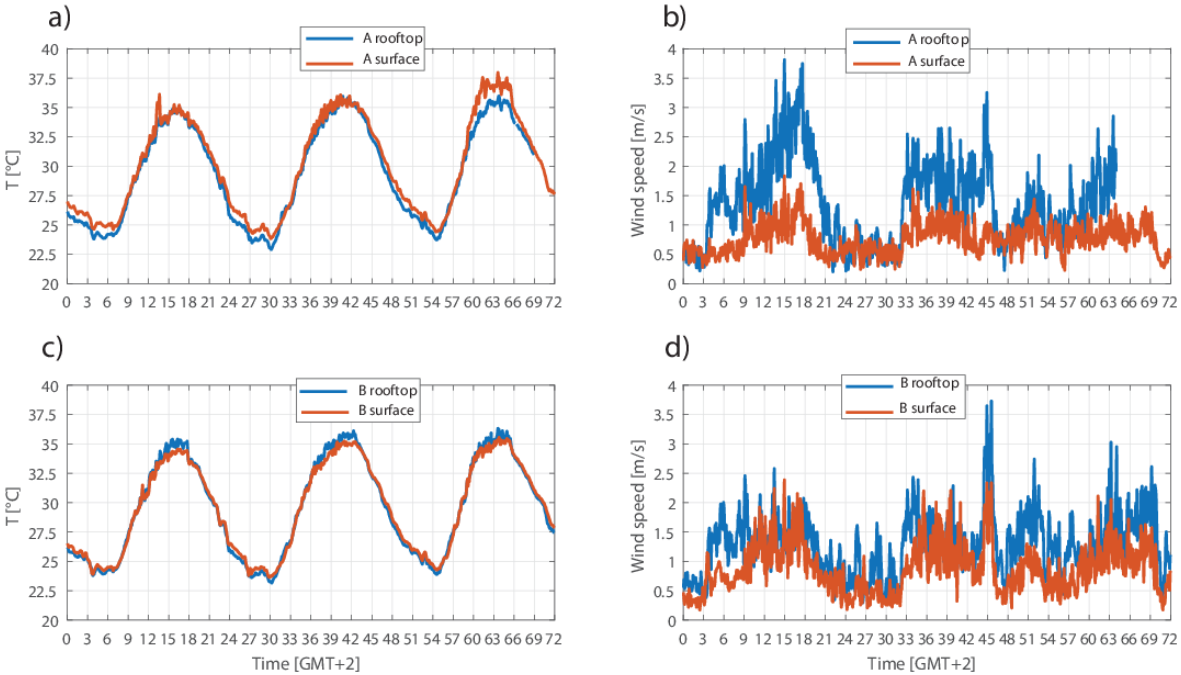


2 street canyons:

- **Same orientation**
- A = painted canyon

  B = reference canyon

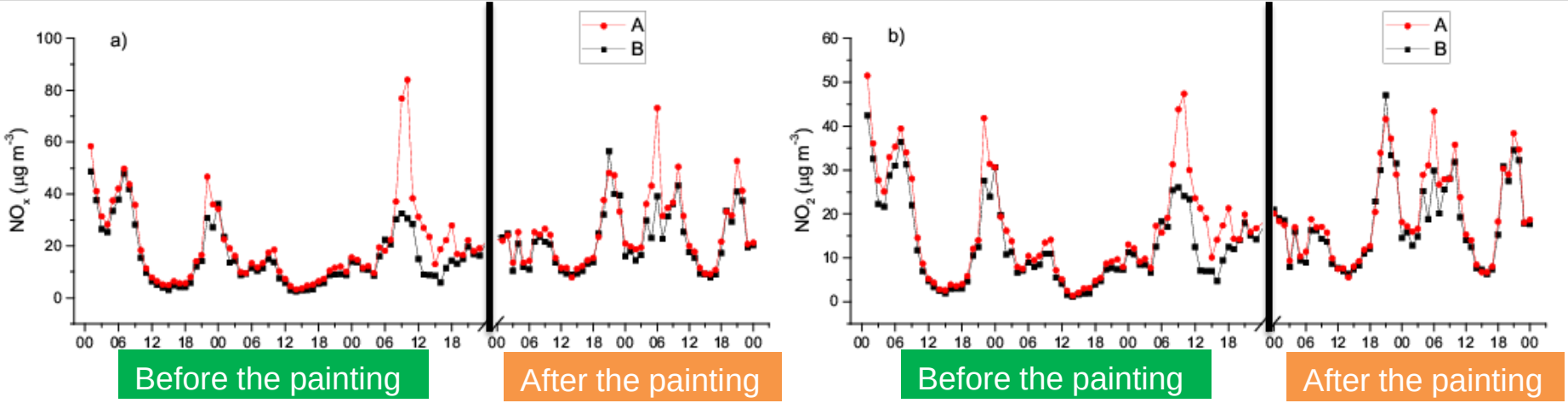
Photocatalytic Coatings: Analysis of Meteorology and Turbulence Levels



Canyon A: stagnation regimes and decoupling from rooftop

Canyon B: flows are well coupled and scale only with the dimension of the air volume allowed by the morphology.

Photocatalytic Coatings: Analysis of NOx Concentrations

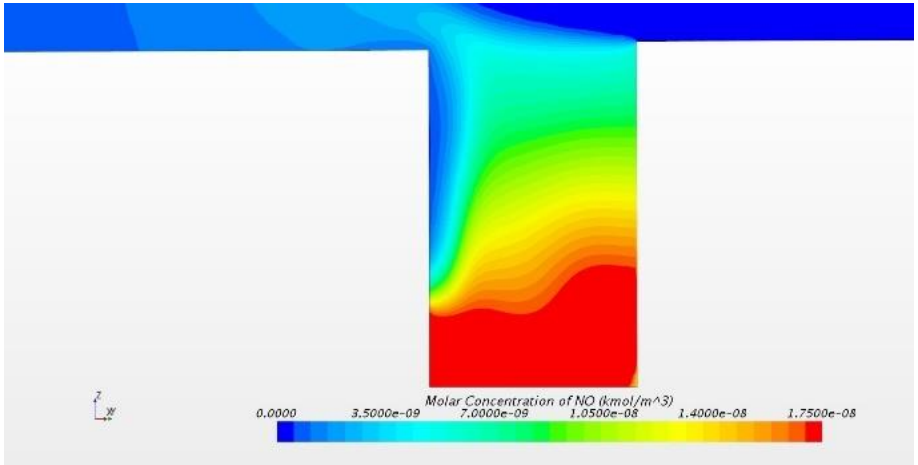


NOx concentratrions generally tend to be higher in canyon A due to different aspect ratios & circulation in the 2 canyons

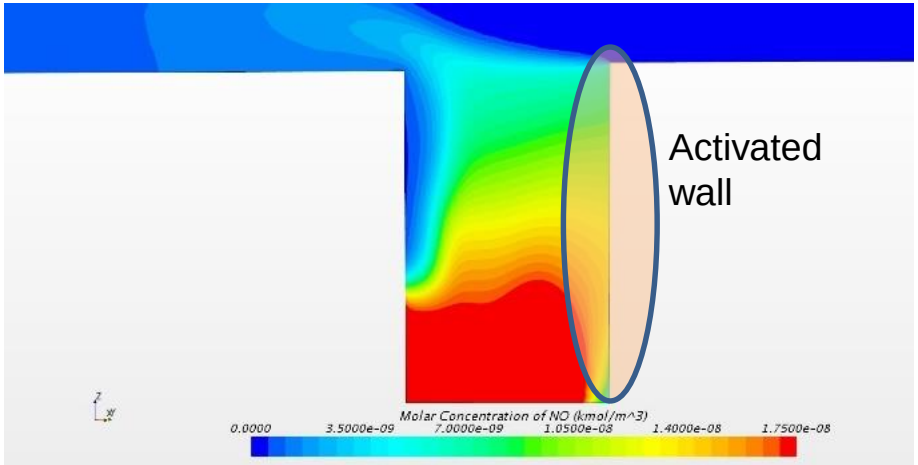
→ 3 independent methodologies to remove the effect of confounding factors

Photocatalytic Coatings: CFD Simulations

Without photocatalytic effect



With photocatalytic effect

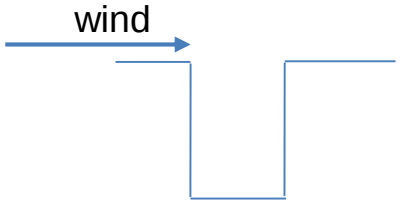


Reduction of pollutant concentration **up to 40**% near the wall in the lower part of the canyon

Photocatalytic Coatings

- Factors that impacts on performance: **meteorological conditions** (e.g. solar radiation, wind direction), **geometry of the buildings**

- **Highest reduction:**
  - **the walls and the street** are **exposed** to the **maximum UV radiation** – at about noon
  - with **wind perpendicular** to the **painted wall**

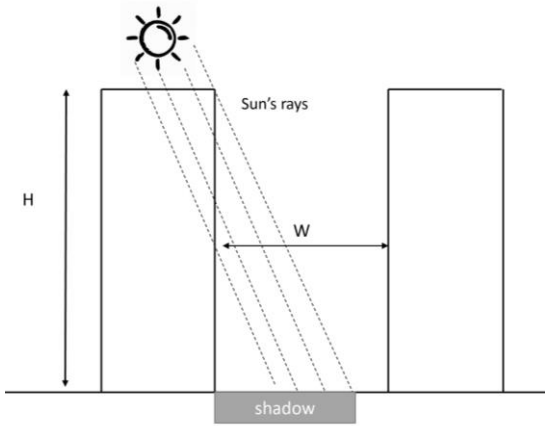


Conclusions
Photocatalytic Coatings

- **Experimental field campaign** to study the different circulation in the 2 canyons and its impacts on pollutant concentrations
- 10-20% NOx reduction on average
- **CFD simulations** indicate a maximum **40% reduction** near the wall

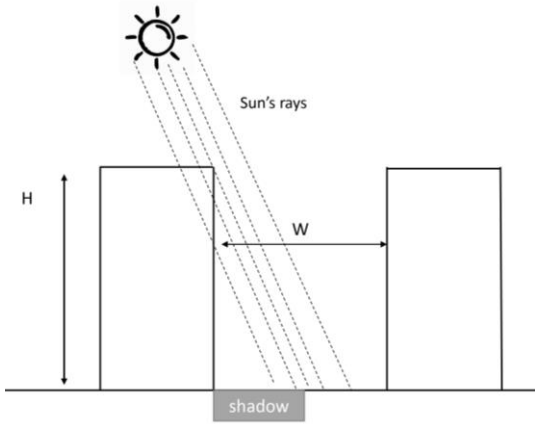
Recommendations: Photocatalytic Coatings

DEEP or NARROW (H/W ≥ 2)



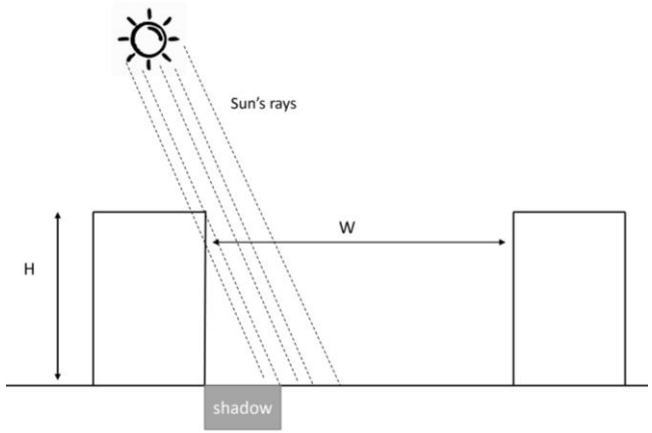
Lowest activation

MODERATELY DEEP or REGULAR (W≈H)



Moderate activation

SHALLOW or WIDE (H/W ≤ 0.5)

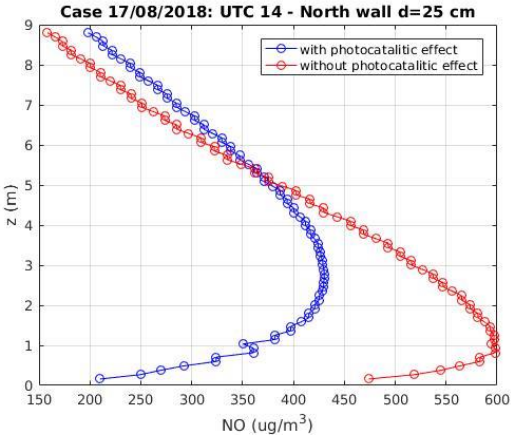


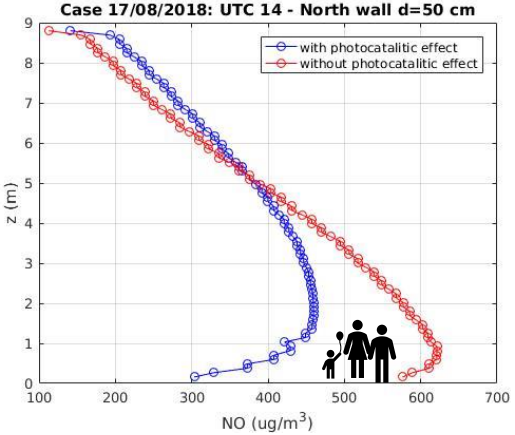
Largest activation!

Recommendations: Photocatalytic Coatings

- **Height**: the largest efficiency in NO_x reduction appears in the first 3m height
- **Distance**: the largest efficiency on NO_x reduction appears near the painted walls (25 – 50 cm)

Not only the walls, but also the roads should be painted





iSCAPE

Low-Boundary Walls

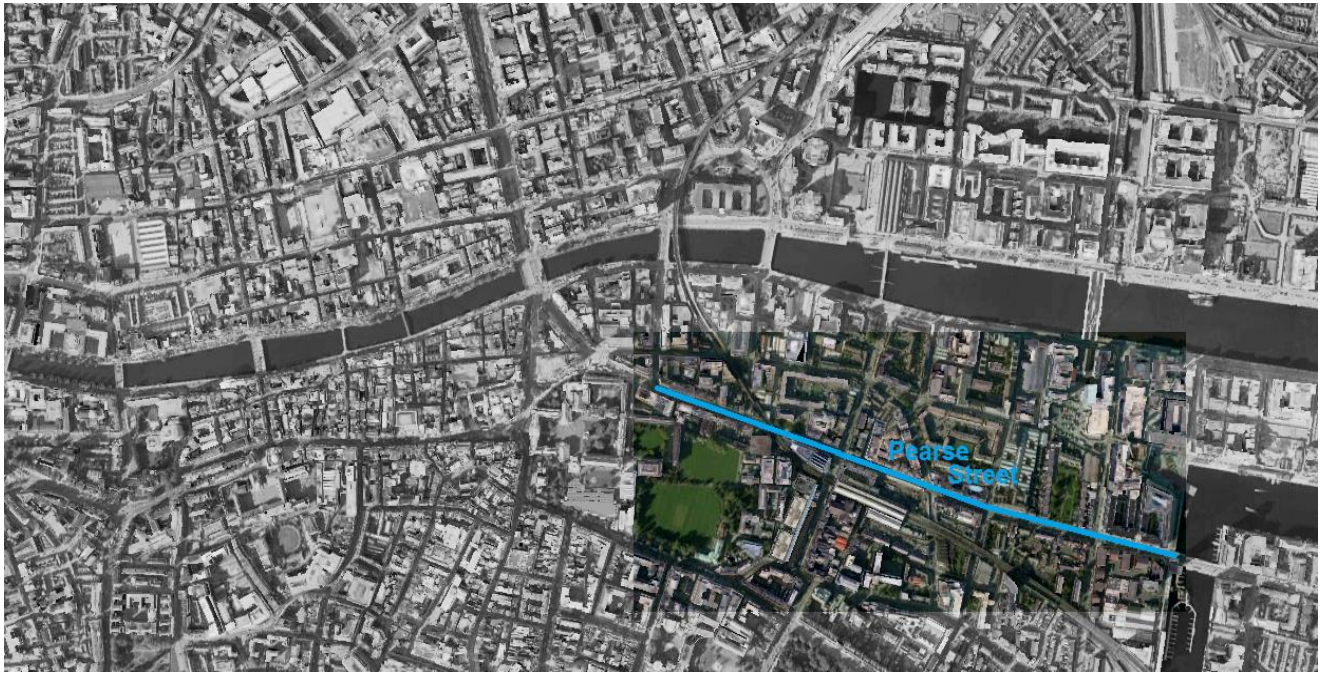
Key Findings and Recommendations

iSCAPE Dublin LivingLab

UCD DUBLIN

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

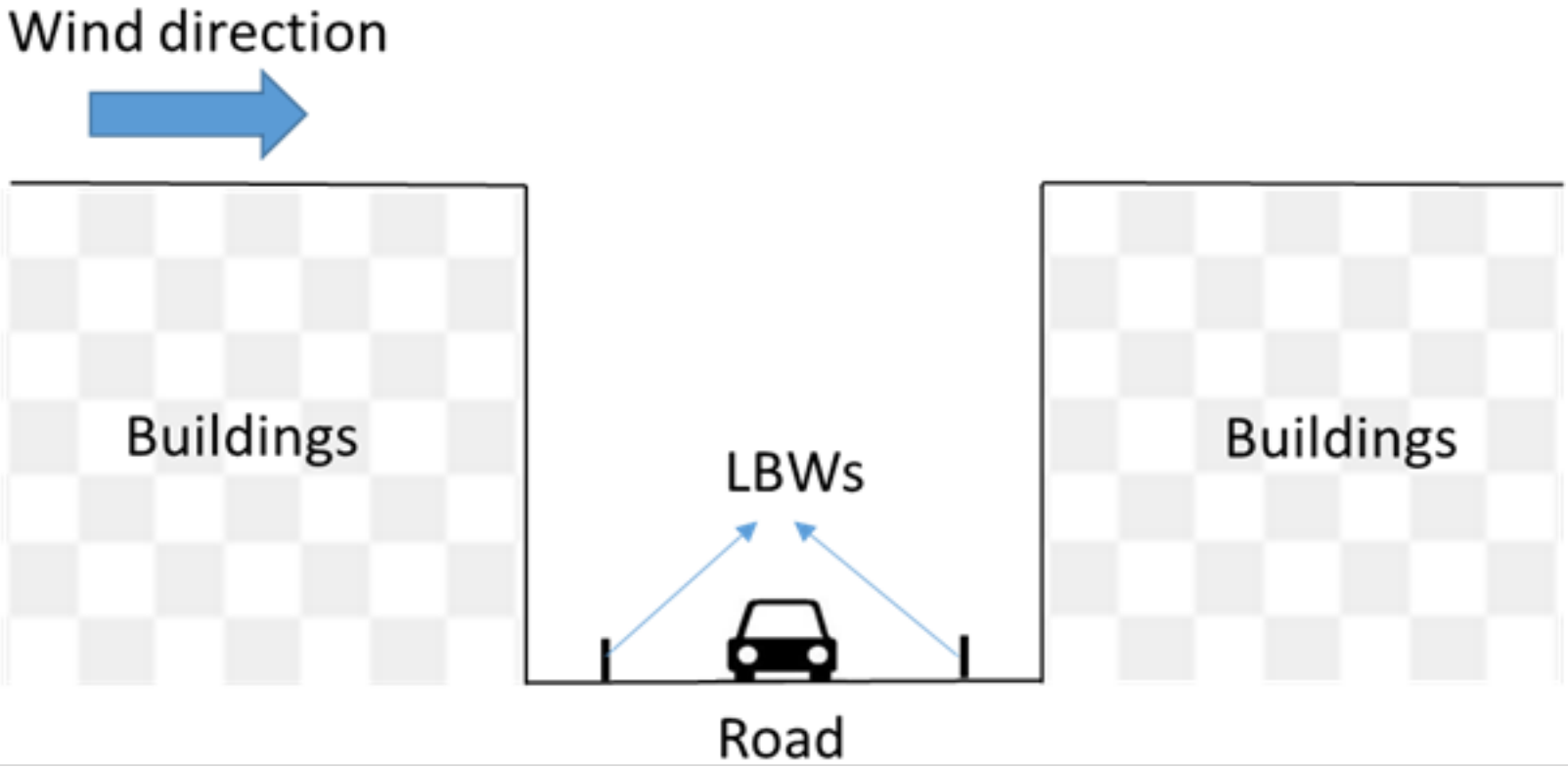
Key Findings on LBW PCS



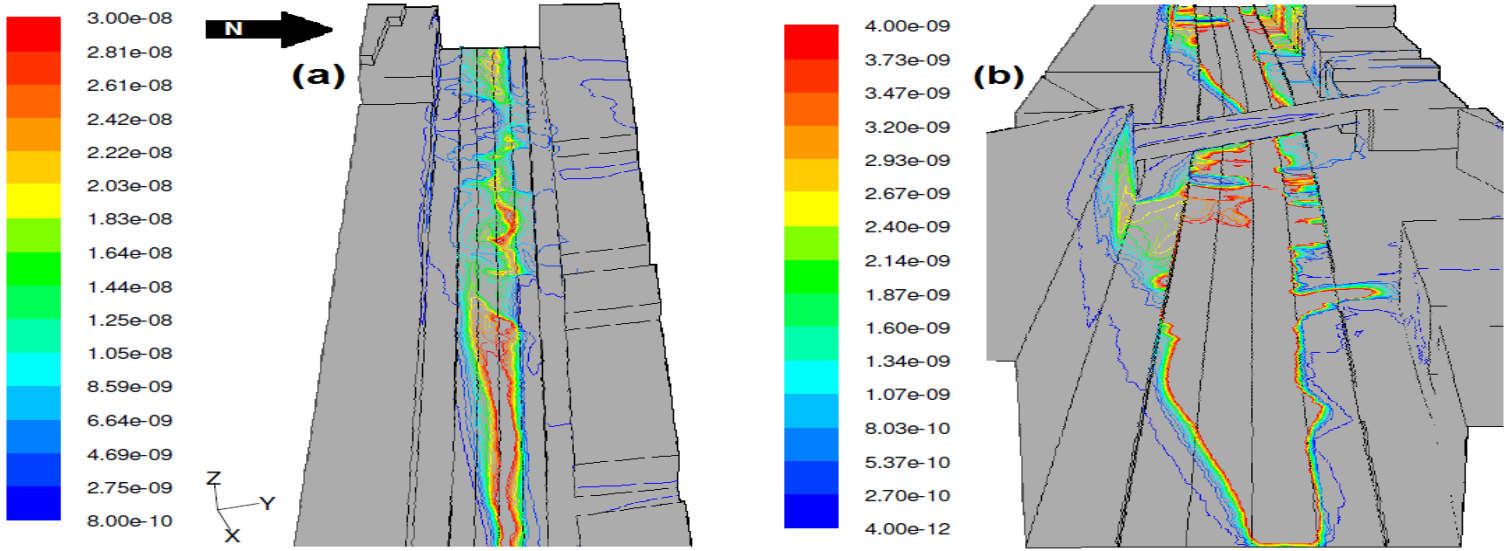
Key Findings on LBW PCS

- Vehicular emissions: primary air pollution source in the urban environment
- High-rise buildings: reduces the exchange of fresh air at roof level and polluted air near street level
- Three options that can reduce air pollution
  - i) controlling the quantity of pollution (g)
  - ii) controlling the emission intensity (g/km)
  - iii) controlling source-receptor pathways (g/m^3)
- PCS: increase dispersion, reduced pollutants concentration at target locations
- Solid barriers: low boundary walls, road-side noise barriers, parked cars, rooftop deflectors

Key Findings on LBW PCS



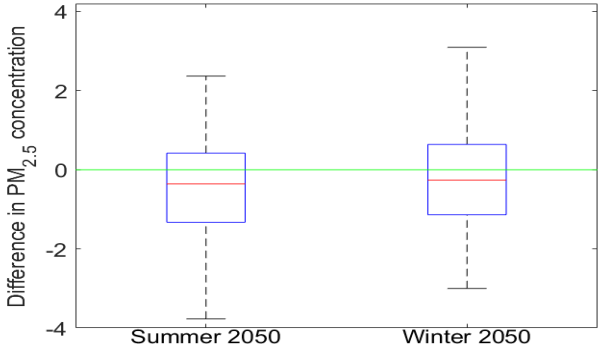
Key Findings on LBW PCS



- LBWs: both positive/negative impact on air quality
- CFD simulations: 16-19% reduction in air pollution at certain sections of the footpaths
- LBWs: improve air quality in sensitive locations of the street: schools, hospitals and office/building entrances

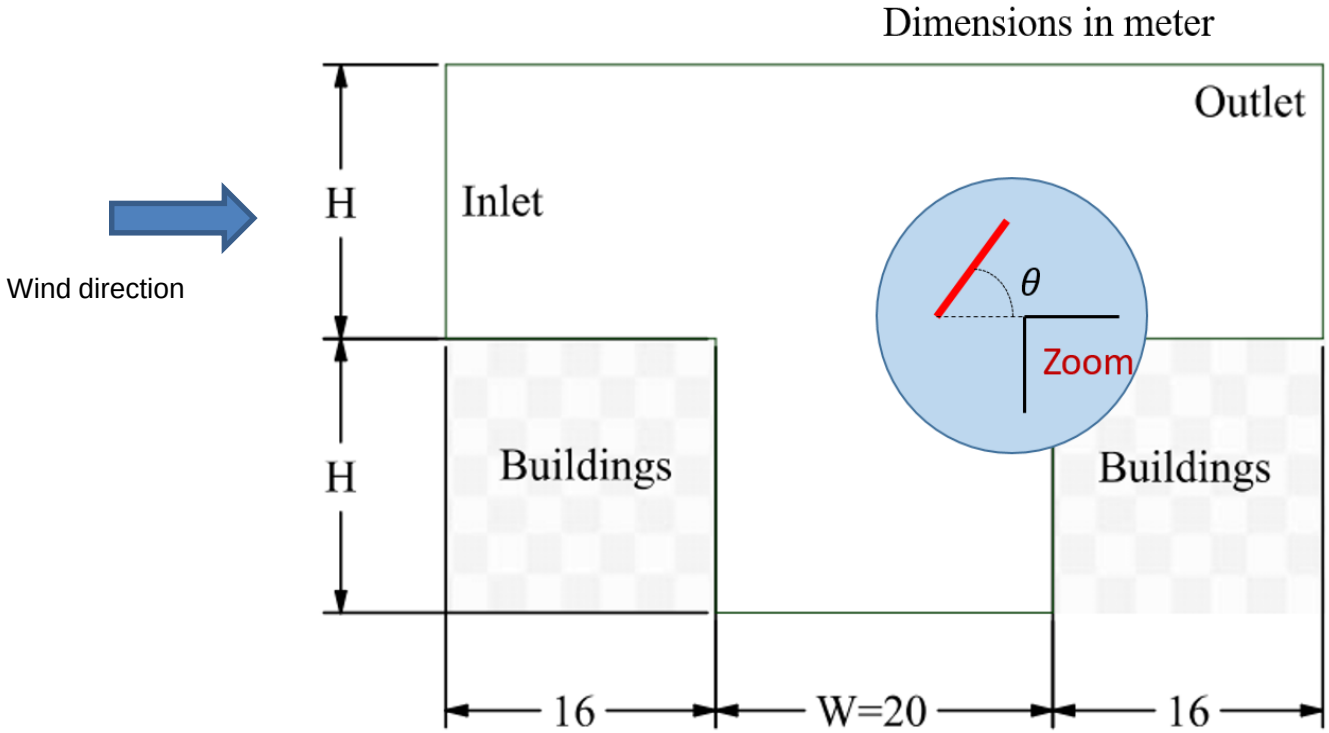
Key Findings on LBW PCS

- Change in air pollution due to LBWs: depends on meteorological factors (wind speed, wind direction) and canyon geometry
- Climate change analysis for Dublin indicated: slow increase in Temperature and Rainfall, Solar Radiation to remain the same
- The wind speed and wind direction is expected to change considerably in the future
- Assuming same traffic volume and emissions from vehicles, pollution concentration is expected to increase considerably in the future scenario for both summer and winter months
- Simulation studies showed that LBWs can improve in air quality for future scenario, and the improvement is expected to be more in summer months

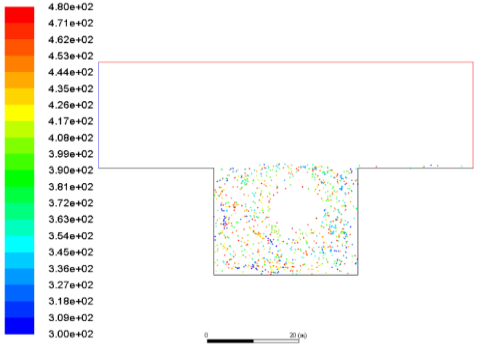


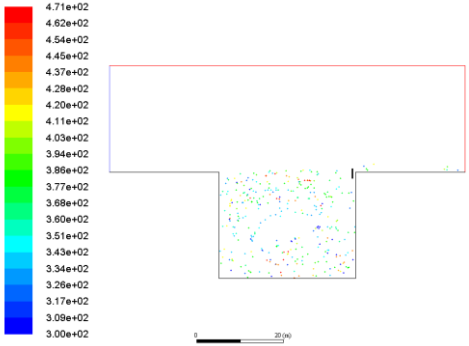
Key Findings on Baffle Plate PCS

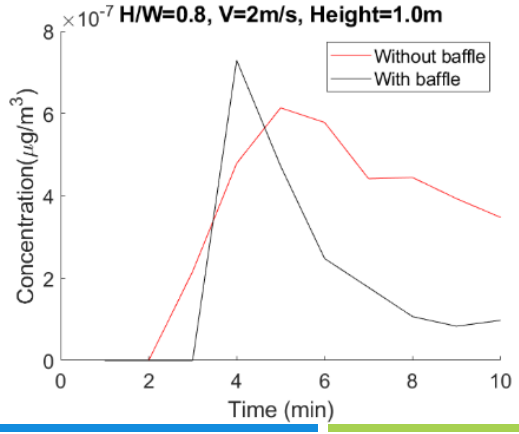
- LBWs can increase air pollution at certain sections of the canyon
- Installation of PCS (LBWs, trees/hedges) restricts movement of pedestrians and traffic
- Application of rooftop deflectors/baffle plate

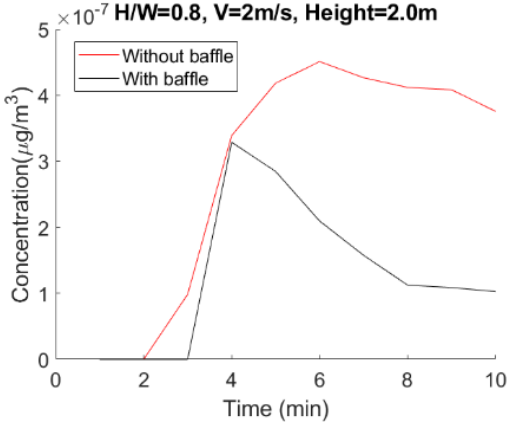


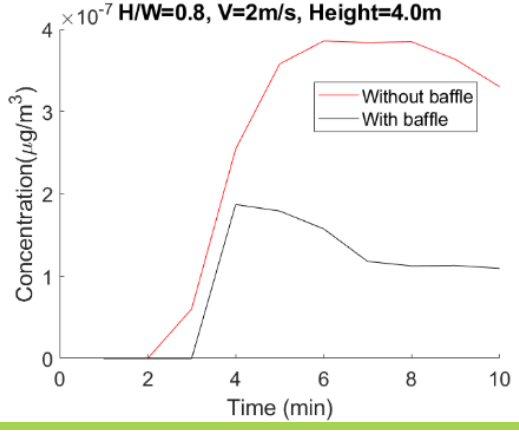
Key Findings on Baffle Plate PCS











Recommendations on LBWs

- Continuous LBWs create maximum efficiency in reducing air pollution for pedestrians
- Gaps in the LBWs needs to be provided at the junctions of roads, near bus stops, buildings and schools
- For visibility of drivers, cyclists and pedestrians, LBWs should be within 0.5-1m
- LBWs should be light-weight, durable and easily transferable, but should not get displaced due to high wind
- LBWs can have reverse effect, so optimal design is necessary
- Rooftop deflectors might be an alternative option to be explored

iSCAPE

Behavioural Change Initiatives

Key Findings and Recommendations

iSCAPE Hasselt LivingLab

UHASSELT

Behavioural Change Initiatives (1)

Informational based Behavioural Intervention Studies

Based on overall mobility behaviour of Citizens

- Short trips within 1-km and 3-km by active travel modes (walk and bicycle)
- Car trips replaceable from reasonable Public transport option
- Reduce participation in non-mandatory outdoor activities

Key Findings

Considerable replaceable potential was found that should be exploited

CITY	Car Trips (Mean values per person for 5-working days)					
	Within 1 km	Walking potential	Within 3 km	Bicycle Potential	Total trips	Public Transportation Potential
HASSELT	0	0	3.28	0.92 (28%)	7.68	1.68 (21%)
BOLOGNA	1.28	0.22	4.06	0.56 (13%)	11.72	3.39 (29%)
GUILDFORD	1.62	0.08	4.77	1.23 (25%)	15.54	2.38 (15.35%)

Consequences of replaceable car trips within 3 km to cycling in a 5-days week per person

CITY	CO_2 Emissions Reduction (%)	Physical Activity Level Improvement (%)
HASSELT	3.01	10.65
BOLOGNA	1.00	3.01
GUILDFORD	2.77	9.85

Key Findings

Considerable replaceable

	Car Trips (Mean values per person for 5-working days)	
5-days week per person	BOLOGNA	1.00	3.01
	GUILDFORD	2.77	9.85

Personal and Ubiquitous Computing
https://doi.org/10.1007/s00779-018-1187-5

ORIGINAL ARTICLE

CrossMark

Estimating pro-environmental potential for the development of mobility-based informational intervention: a data-driven algorithm

Shiraz Ahmed[1] · Muhammad Adnan[1] · Davy Janssens[1] · Erika Brattich[2] · Ansar-ul-Haque Yasar[1] · Prashant Kumar[3] · Silvana di Sabatino[2] · Elhadi M. Shakshuki[4]

Key Findings

- 40% of participants expressed & adopted at least one provided suggestion
- Statistical analysis of control and treatment group indicates that there is significant
  - Reduction in car use for short trips (under 3 km) that causes significant increase in use of active travel modes (more on bicycling).
  - No significant changes are observed for increase use of PT and decrease in cold starts.

Behavioural Change Initiatives (2)

Based on route to school followed by children and escorting parents/guardians

- Exposure to pollutant (NO_2) for followed routes and available alternatives routes
- Alternative routes are suggested that are less polluted (as a customized informational intervention)

Informational based Behavioural Intervention Studies

Key Findings

% Participant's exposure category shift from actual to alternative routes			
Alternative Routes	Current Routes		
	Low	Moderate	High
Low	30	17	7
Moderate	3	20	10
High	0	0	13

77 % of the participants adopted the suggested alternative routes

Ahmed et al. 2019. *Sustainable cities and Society,* Under review.

Key Findings

A Route to school Informational Intervention for Air Pollution Exposure Reduction

Shiraz Ahmed, Muhammad Adnan, Davy Janssens, Geert Wets
Transportation Research Institute- IMOB, Hasselt University, Agoralaan, 3590 Diepenbeek, Belgium

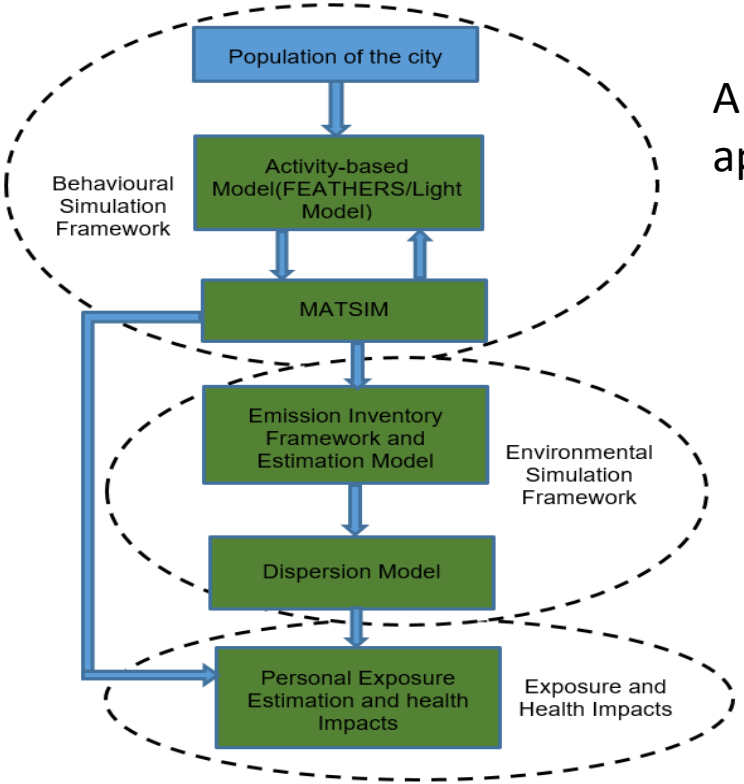
High	0	0	13

77 % of the participants adopted the suggested alternative routes

Ahmed et al. 2019. *Sustainable cities and Society,* Under review.

Behavioural Change Initiatives (3)

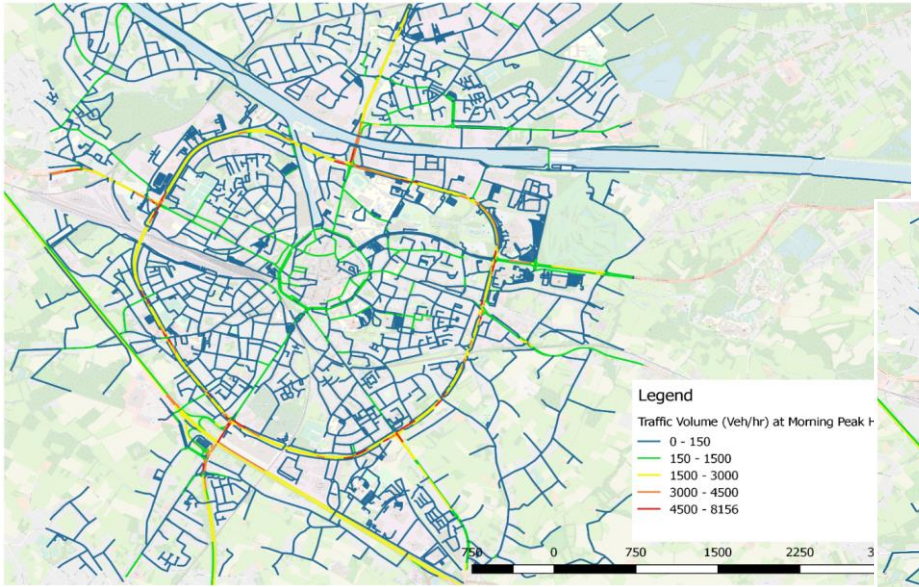
Strategic Behavioural Intervention- Simulation Studies



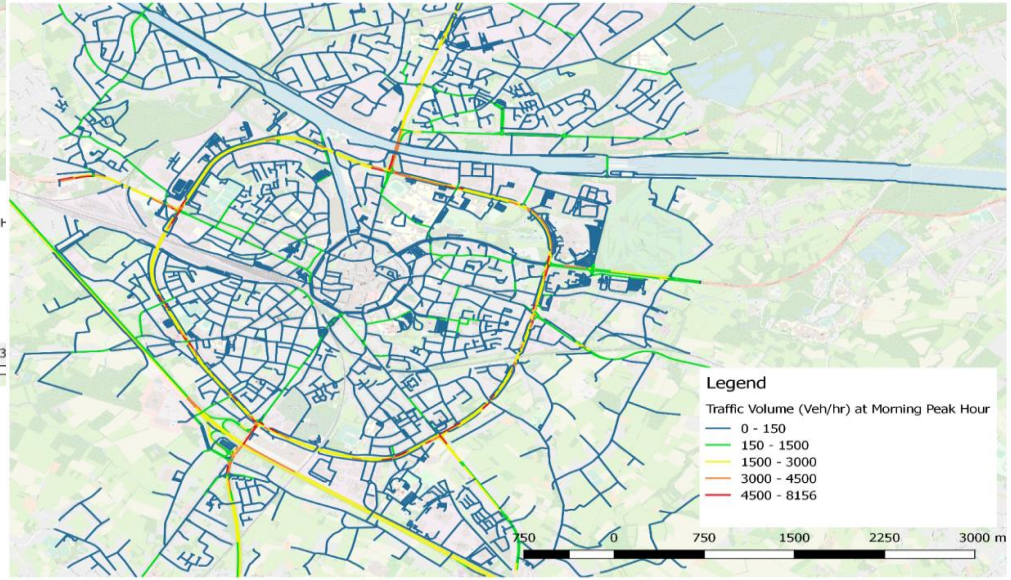
A simulation model chain follows an activity-based approach

- Estimation of dynamic exposure to pollutants for assessment of health impacts
- Assessing the effects of mobility-based hard interventions
  - Car access restrictions/ Electric mobility
  - Improvement of Public transport infrastructure
  - Opening times of facilities

Key Findings: Hasselt

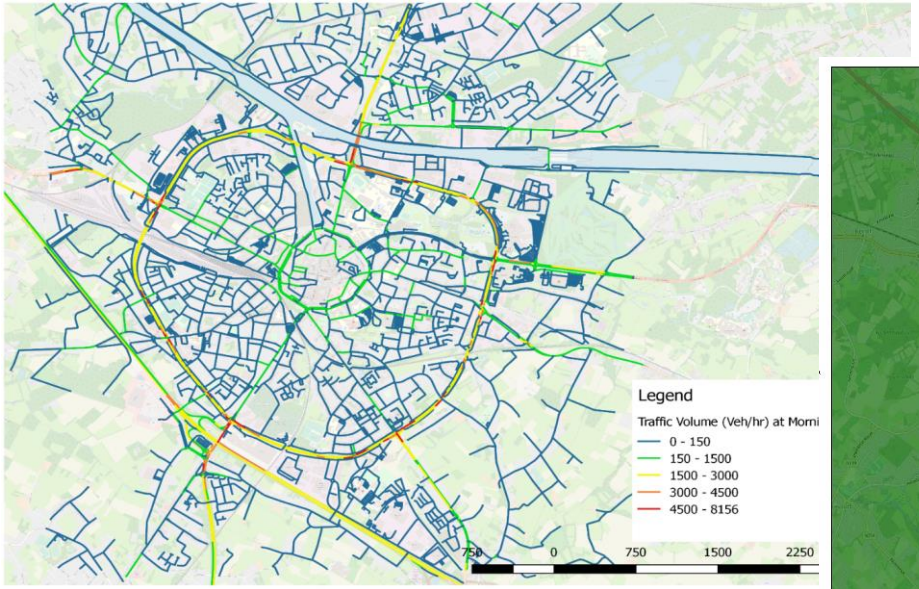


Base case

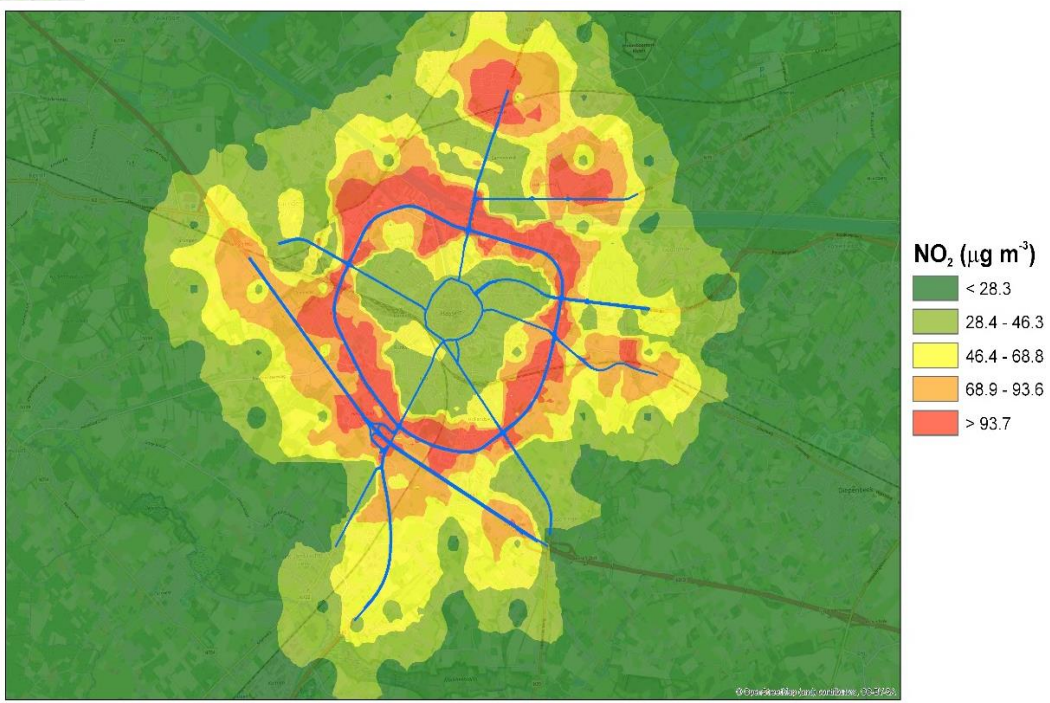


Restricted cars case

Key Findings: Hasselt



Base case

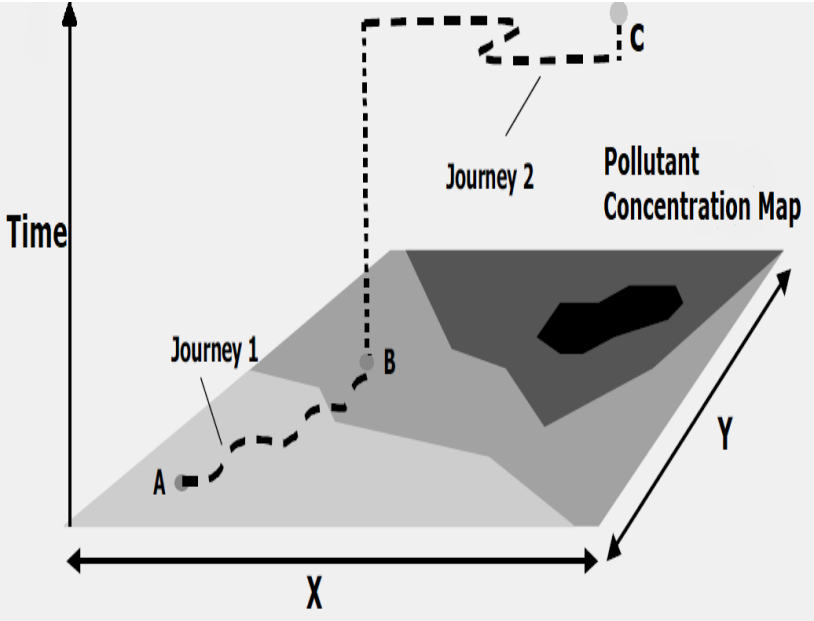


Restricted cars case

Key Findings

City	Policies	Increase use of PT	Changes (Population Segments)	NO_2 Reductions	PM_{10} Reductions
Hasselt	Car- Access Restriction	👍	Students Retired Person	★★★	★★
	Increase Bus Frequency	👎	Students	★	★
Bologna	Electric Centre with Car Access-restriction	👍	Low income people Students	★★	★
	Opening times of facilities	👎	-	-	-
Vantaa	Car- Access Restriction	👍	Females Students Non-Workers	★	★
	Increase Bus Frequency	👎	-	-	-

Exposure Estimates and Health impacts- Key Findings



% Difference in Years of life lost based on Dynamic Exposure for NO_2 - Age category 30-54 years (Hasselt)		
Gender	Base Case – Car Access Restriction	Base Case – Increase Bus Frequency
Male	6.78% ↓	2.25% ↓
Female	5.32% ↓	1.95% ↓

% Difference in Years of life lost* based on (Dynamic – Static) Exposure for NO_2 - Age category 30-54 years (Hasselt)			
Gender	Base Case	Car Access Restriction	Increase Bus Frequency
Male	3.98 %	3.25%	3.87%
Female	2.78 %	2.45%	2.65%

Recommendations (1)

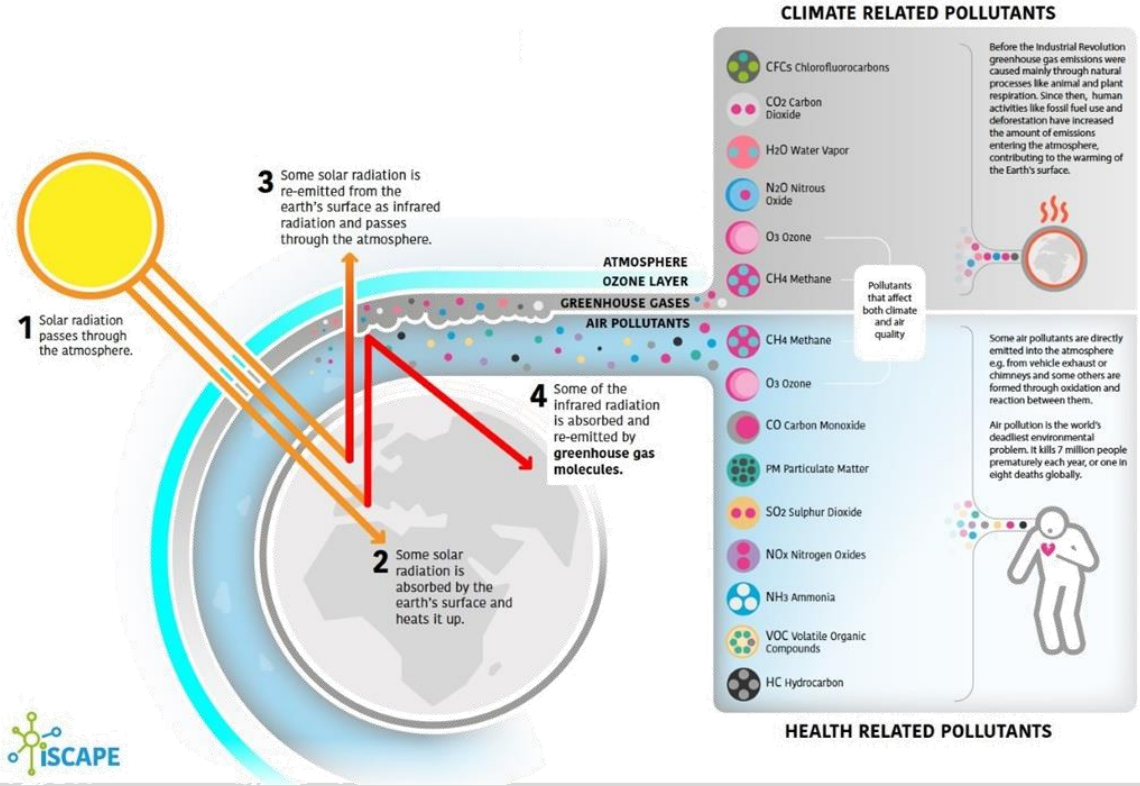
Informational Intervention are effective if following points are considered

- Customized individual coaching approach is followed
- Behavioural change is easy to adopt (contains not too much efforts)
- Behavioural changes bring short and long term benefits
- Intervention is based on the relevant issue (i.e. Society in general is concerned with the issue)
- Intervention can be more effective if target audience is specific and more vulnerable to the issue

Recommendations (2)

- Informational & structural interventions should be coupled for optimal results.
- **Restricting car traffic intervention** is more effective in relation to efficient mobility, air quality and health impacts, however, could raise equity issues.
- Structural interventions that are improving mobility may not always bring desirable improvement in air quality and health impacts and vice versa.
- Integrated agent-based simulators provide a profound framework for assessing structural interventions.

Linkage Between Air Pollution and Climate Change



iSCAPE

Air Quality and Climate Change

Key Findings and Recommendations

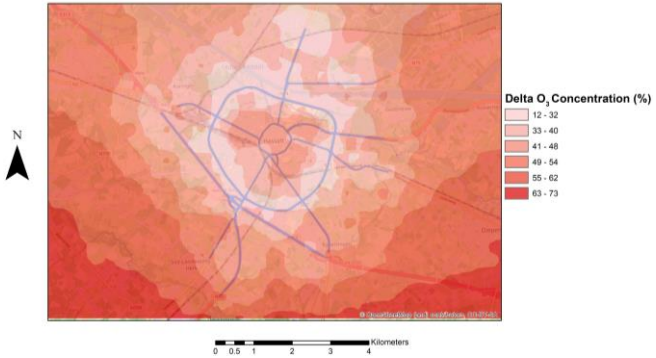
iSCAPE Bologna LivingLab

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

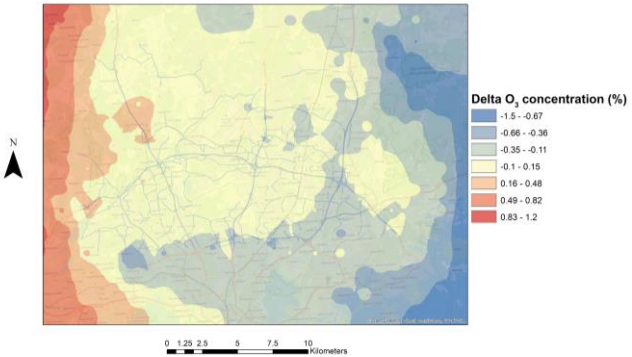
Interactions between Air Pollution & Climate Change

Southern EU

Central EU

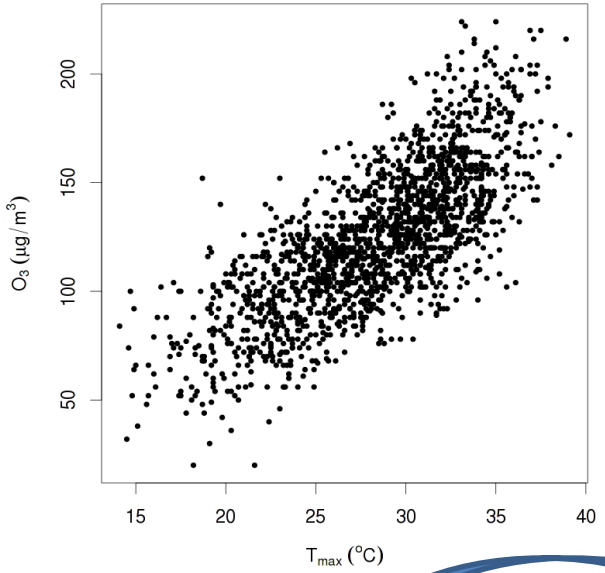


Northern EU



O_3 tend to increase across Europe in the future

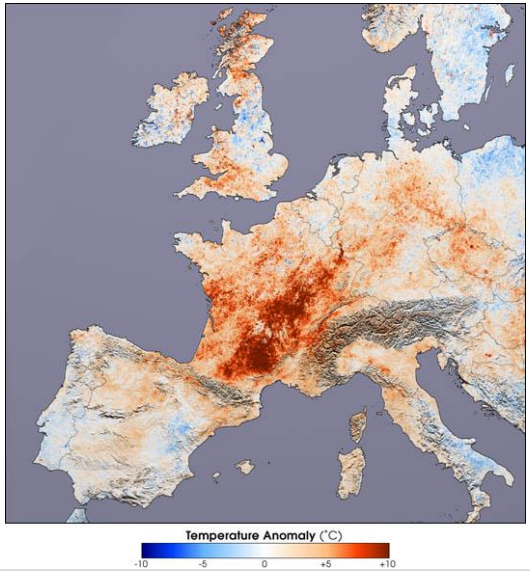
Interactions between Air Pollution & Climate Change



Increase in temperature → + O_3 → Increase in temperature

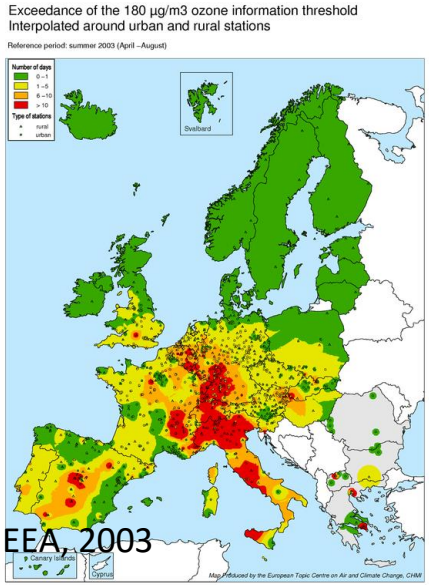
Identification of Episodes Liaising Air Quality & Climate Change

1. O_3 peaks during summer heat waves, which are going to increase in frequency and duration (EEA, 2016; Coumou et al., 2015)



Temperature anomaly in July 2003 relative to July 2001

Data provided by the MODIS Land Science Tea

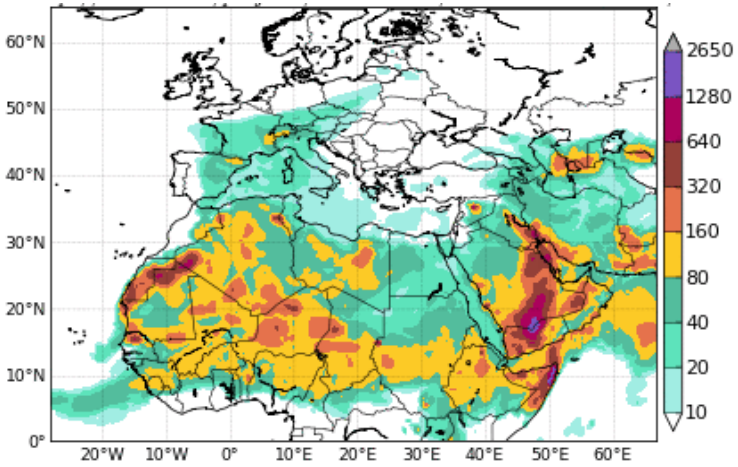


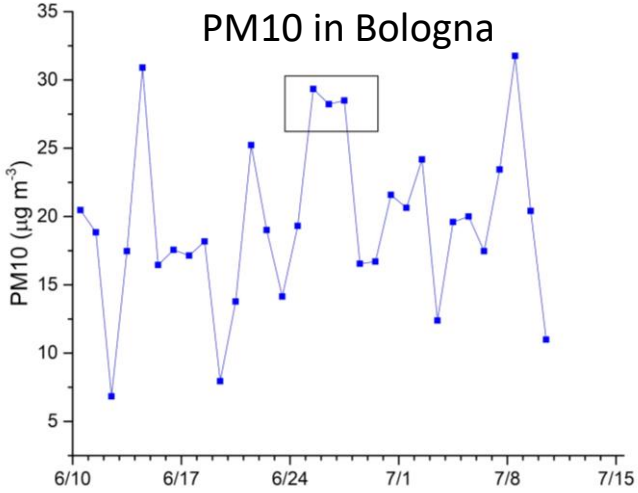
EEA, 2003

Identification of Episodes Liaising Air Quality & Climate Change

1. O_3 peaks during summer heat waves, which are going to increase in frequency and duration (EEA, 2016; Coumou et al., 2015)
2. Strong, hot winds from Africa transporting high concentrations of PM

Summer 2019: heat wave end of June

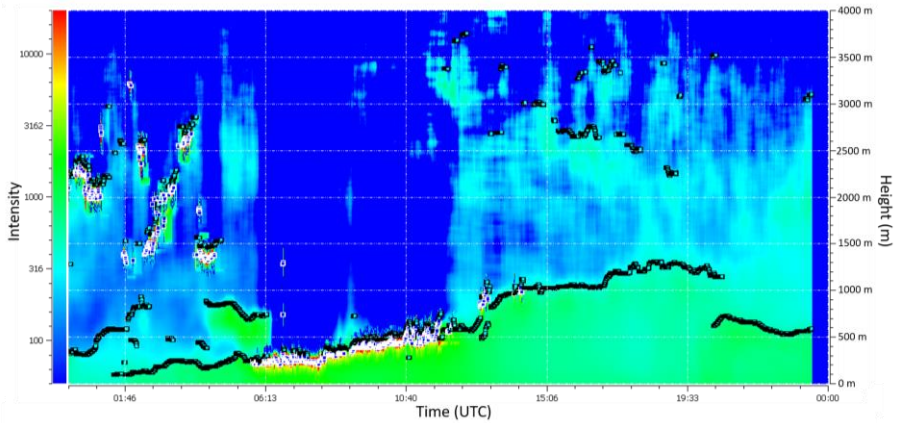


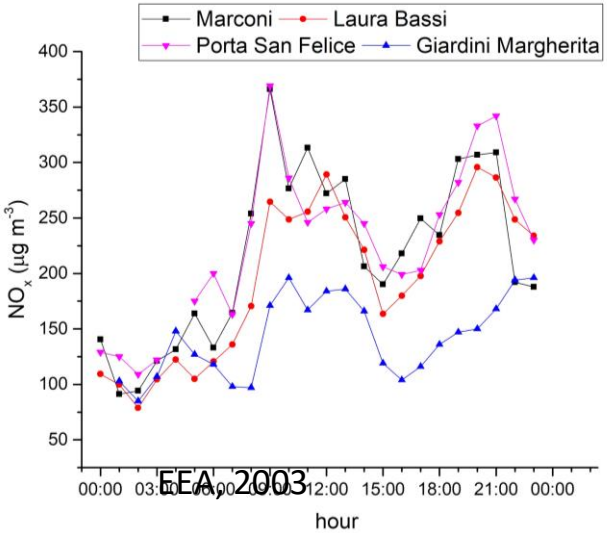


Identification of Episodes Liaising Air Quality & Climate Change

1. O_3 peaks during summer heat waves, which are going to increase in frequency and duration (EEA, 2016; Coumou et al., 2015)
2. Strong, hot winds from Africa transporting high concentrations of PM
3. Increase in stagnation events because of higher persistence of blocking anticyclones

January 2018





EEA, 2003

Identification of Episodes Liaising Air Quality & Climate Change

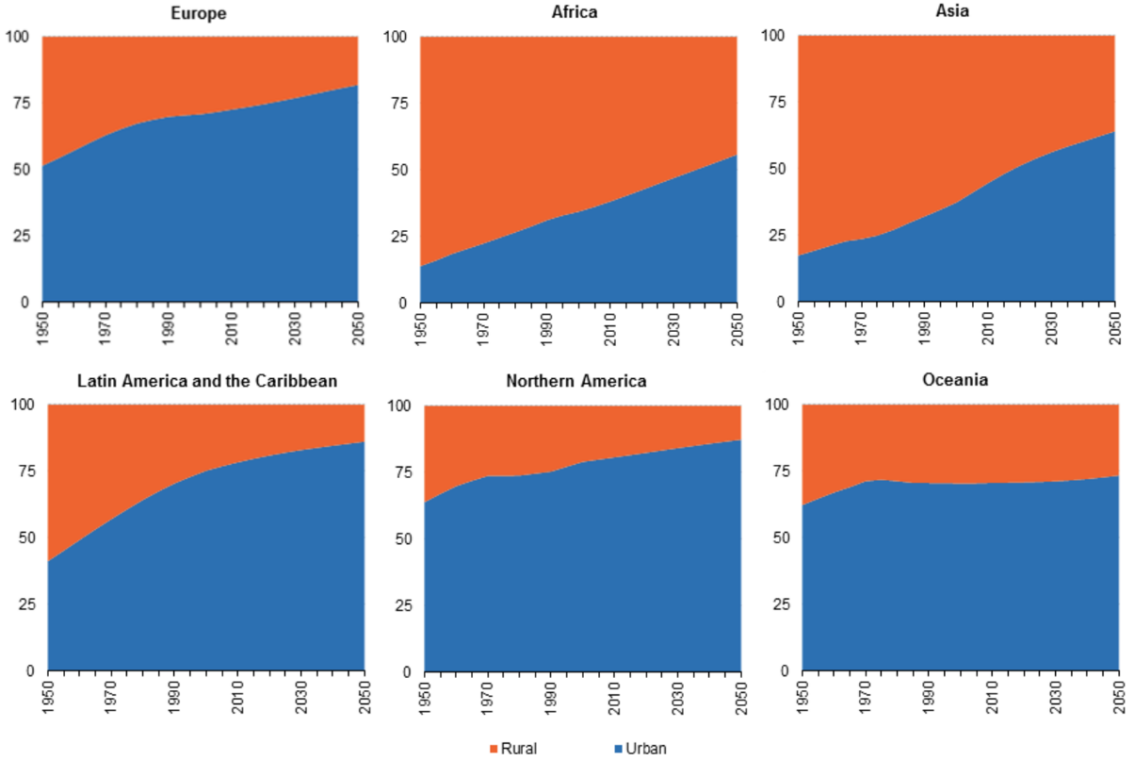
1. Attribution of single events to climate change not straightforward
2. Need to compute the change in likelihood of the events under interest (such as heat waves, droughts and heavy precipitation events) in a climate with and without anthropogenic forcing
3. **Plans** need to **consider both air quality & climate change**
4. Need close collaboration between stakeholders & scientific experts of various disciplines, i.e. in **climate**, **meteorology**, **air pollution**

Climate Change

Key Findings and Recommendations

FINNISH METEOROLOGICAL INSTITUTE

Climate Change

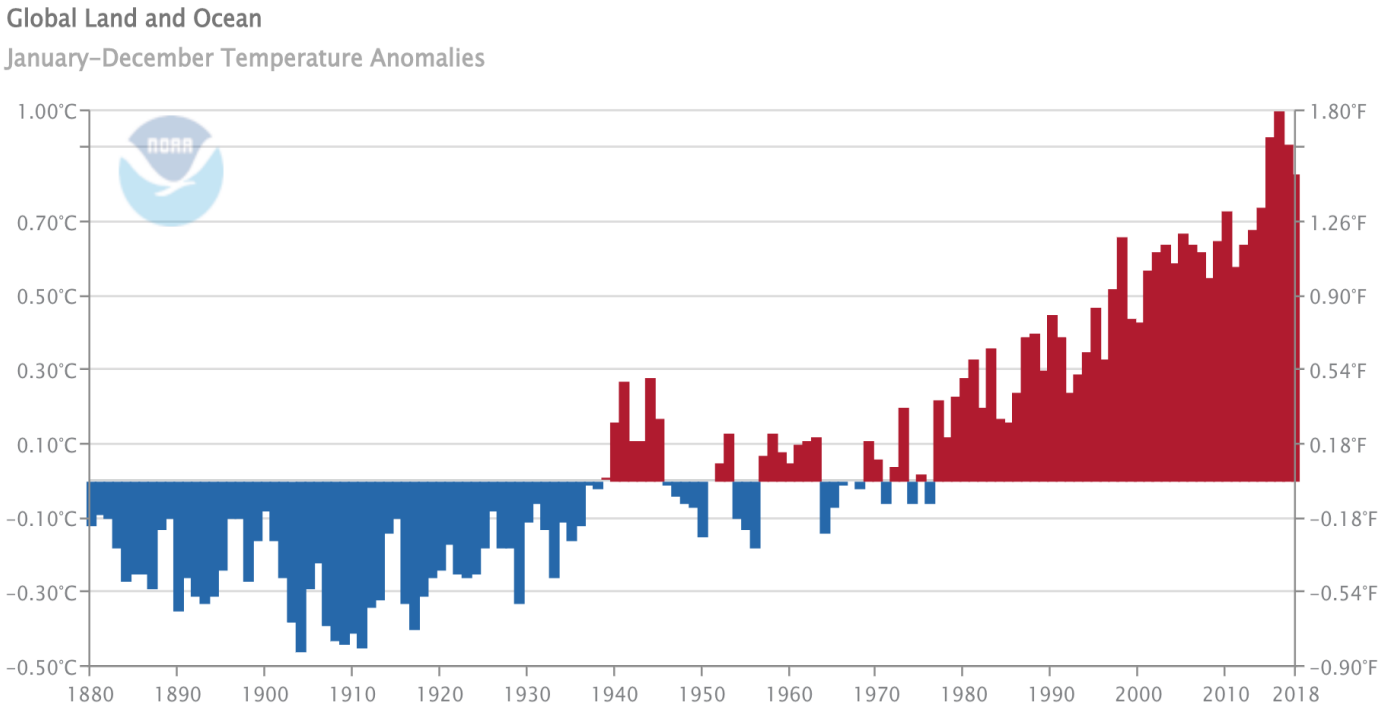


(*) United Nations data are based on national definitions; as such there may be a discrepancy with respect to the Eurostat data used elsewhere in this publication.

- Cities are coming more and more populated
- Cities must adapt to the changing climate

Share of urban and rural populations, 1950–2050[1] (% of the total population).
Source: World urbanisation prospects — United Nations, Department of Economic and Social Affairs, Population Division (2014).

Climate Has Already Changed

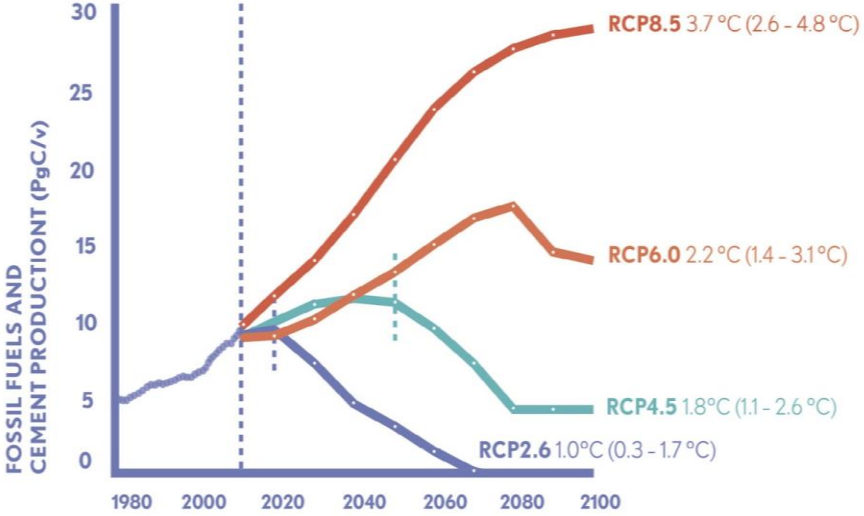


Annual global (land and ocean) temperature anomalies with respect to the 20th century average. From: NOAA National Centre for Environmental Information, Climate at a Glance: Global Time Series, published August 2019, retrieved on September 7, 2019 from https://www.ncdc.noaa.gov/cag/.

Climate Change Emission Scenarios

REPRESENTATIVE CONCENTRATION PATHWAYS (RCP)

For the Fifth Assessment Report of IPCC, the scientific community has defined a set of four new greenhouse gas scenarios, referred to as the Representative Concentration Pathways (RCP).



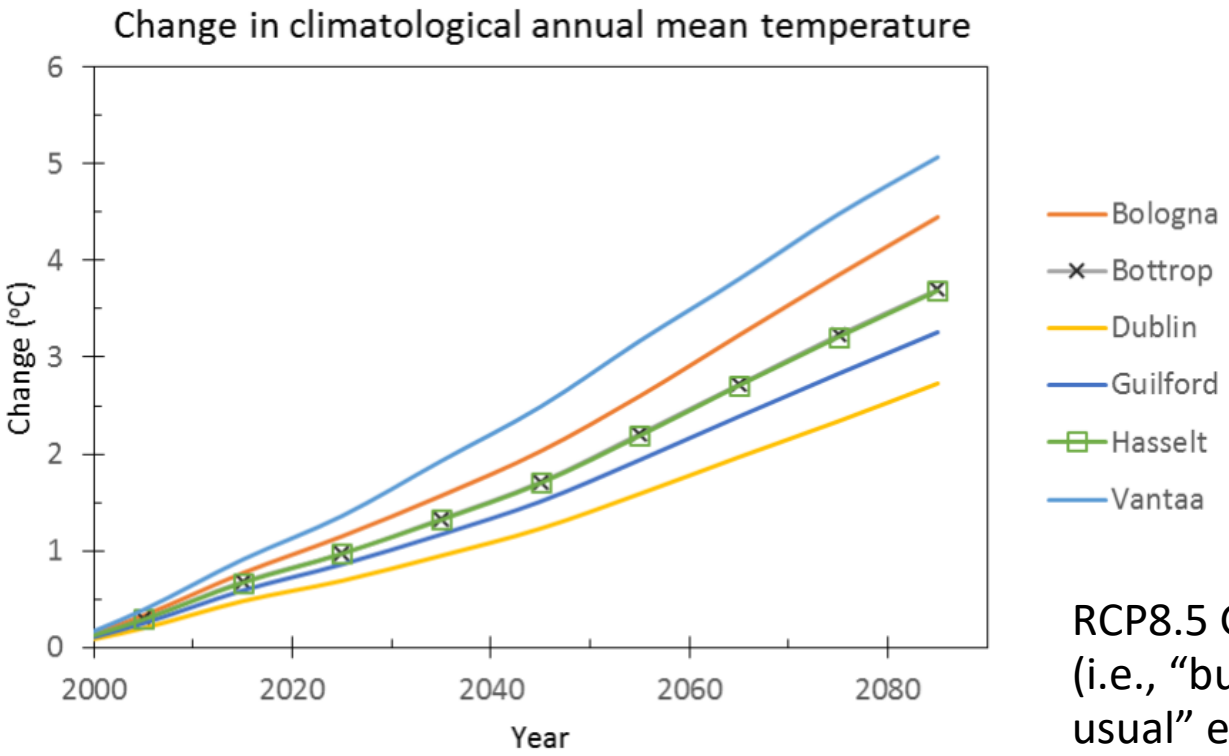
RCP 8.5
Emissions of greenhouse gases continue to grow at current rate

RCP 6.0

RCP 4.5

RCP 2.6
Substantial reductions of greenhouse gas emissions

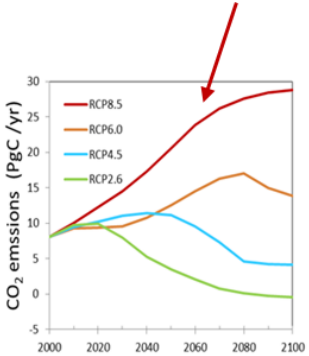
Key Findings
Projected Warming in iSCAPE Cities



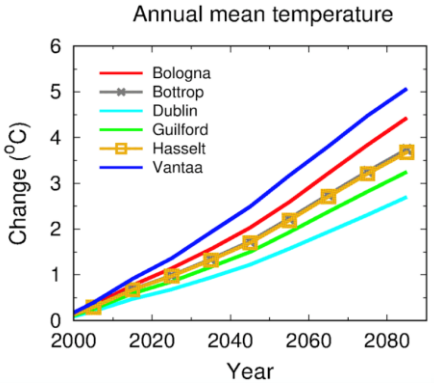
Multi-model mean scenarios based on 28 CMIP5 Global Climate Models (GCMs)

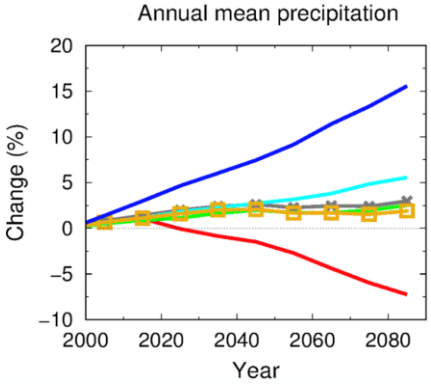
Projected changes in 30-year means with respect to 1981-2010

RCP8.5 GHG scenario (i.e., “business as usual” emissions)

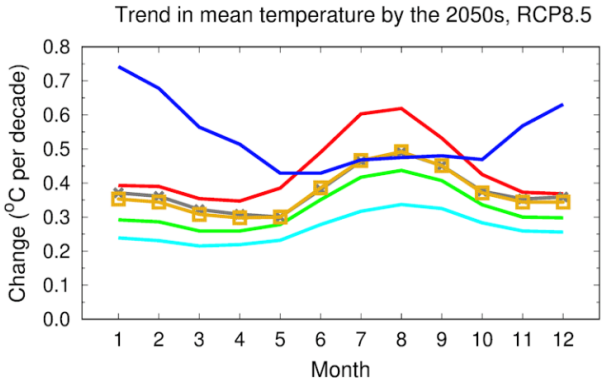


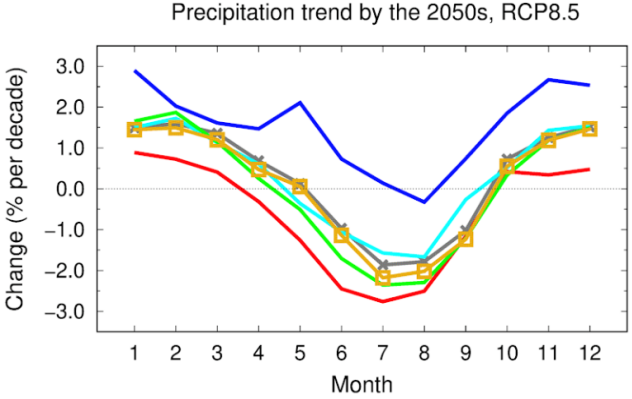
Key Findings
Projected Warming in iSCAPE Cities





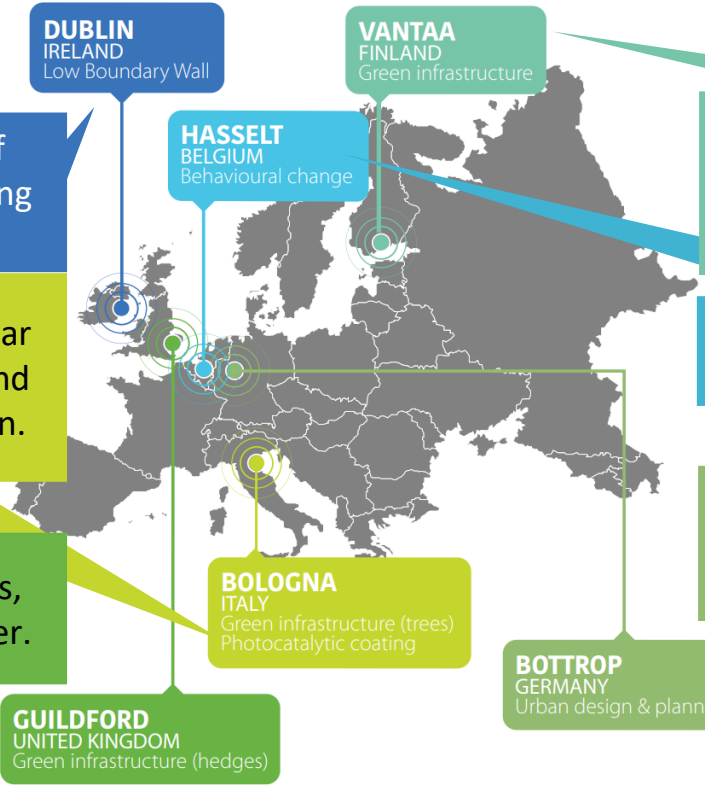
Predicted change in **annual mean** temperature (left) and precipitation in iSCAPE cities according to the RCP8.5 scenario.





Monthly trends in mean temperature (left) and precipitation in iSCAPE cities by the 2050s according to the RCP8.5 scenario.

Key Findings
Climate Change According to RCP8.5



The projected long-term trend of warming is weakest in Dublin among ISCAPE cities.

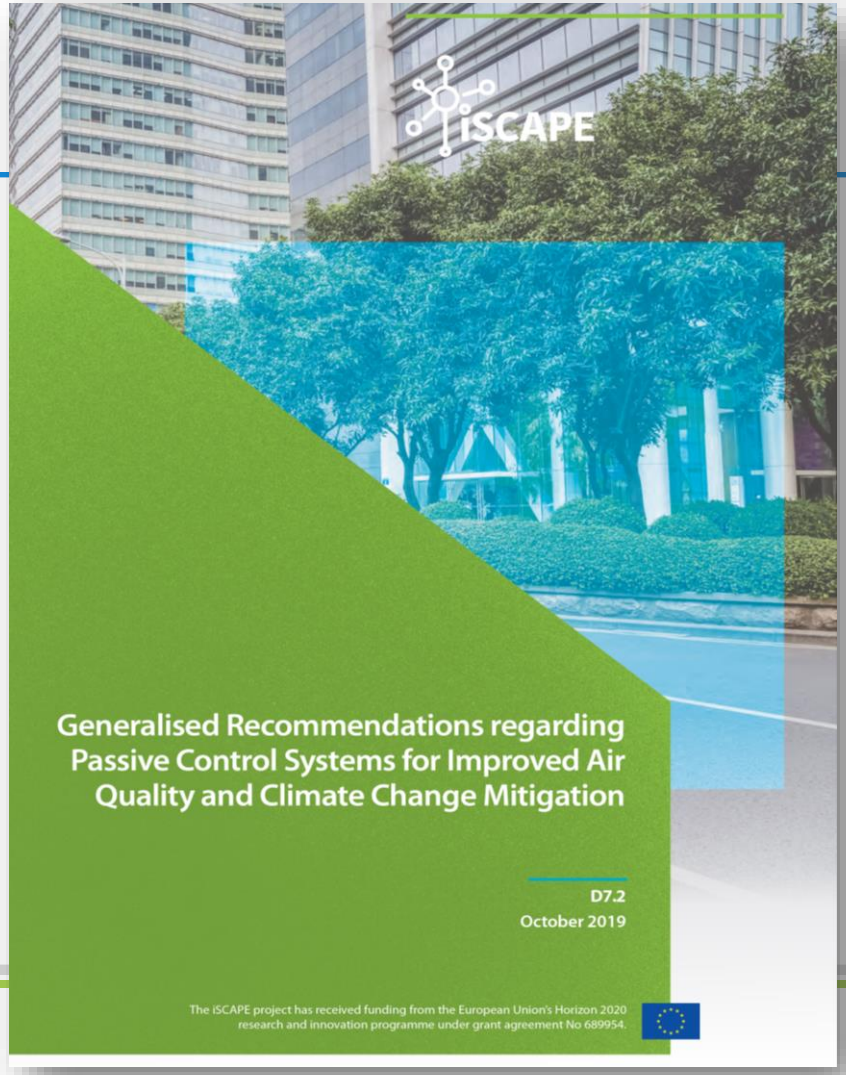
Higher temperatures and more solar radiation (especially in summer) and reductions in summer precipitation.

Similar to Dublin in several aspects, but the changes are generally larger.

Higher temperatures, but the trend is stronger in winter than in summer (unlike in other cities)

Very similar to those for the nearest iSCAPE city, Bottrop.

Similar to Bologna in temperature and precipitation but in general weaker.


iSCAPE
Generalised Recommendations regarding Passive Control Systems for Improved Air Quality and Climate Change Mitigation
D7.2
October 2019
The iSCAPE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 689954.

Scientific reports

Reports produced by iSCAPE are listed and described below.

- Living Labs beyond iSCAPE (August 2019) **NEW**
- Local stakeholders report (August 2019) **NEW**
- Citizen Science Community Reports (May 2019)
- Community Feedback Reports (March 2019)
- Report on High-end and low-cost sensing platforms
- Report on footprint of passive control systems (Updated October 2018)
- Report on solutions at urban level (FULL REPORT NOW AVAILABLE FOR DOWNLOAD)
- Report on Real time reporting system for monitoring with sensor technologies (Updated October 2018)

Concluding remarks
Sustainability (resources)

iSCAPE Guildford LivingLab

iSCAPE Bottrop LivingLab

iSCAPE Bologna LivingLab

iSCAPE Dublin LivingLab

iSCAPE Hasselt LivingLab

iSCAPE Vantaa LivingLab

GUILDFORD BOROUGH

bottrop.

COMUNE DI BOLOGNA

RegioneEmilia-Romagna

Dublin City Council
Comhairle Cathrach Bhaile Átha Cliath

HASSELT HEEFT HET.

Vantaa

Acknowledgements

iSCAPE (Improving Smart Control of Air Pollution in Europe) project is funded by the European Community's H2020 Programme (H2020-SC5-04-2015) under the Grant Agreement No. 689954.

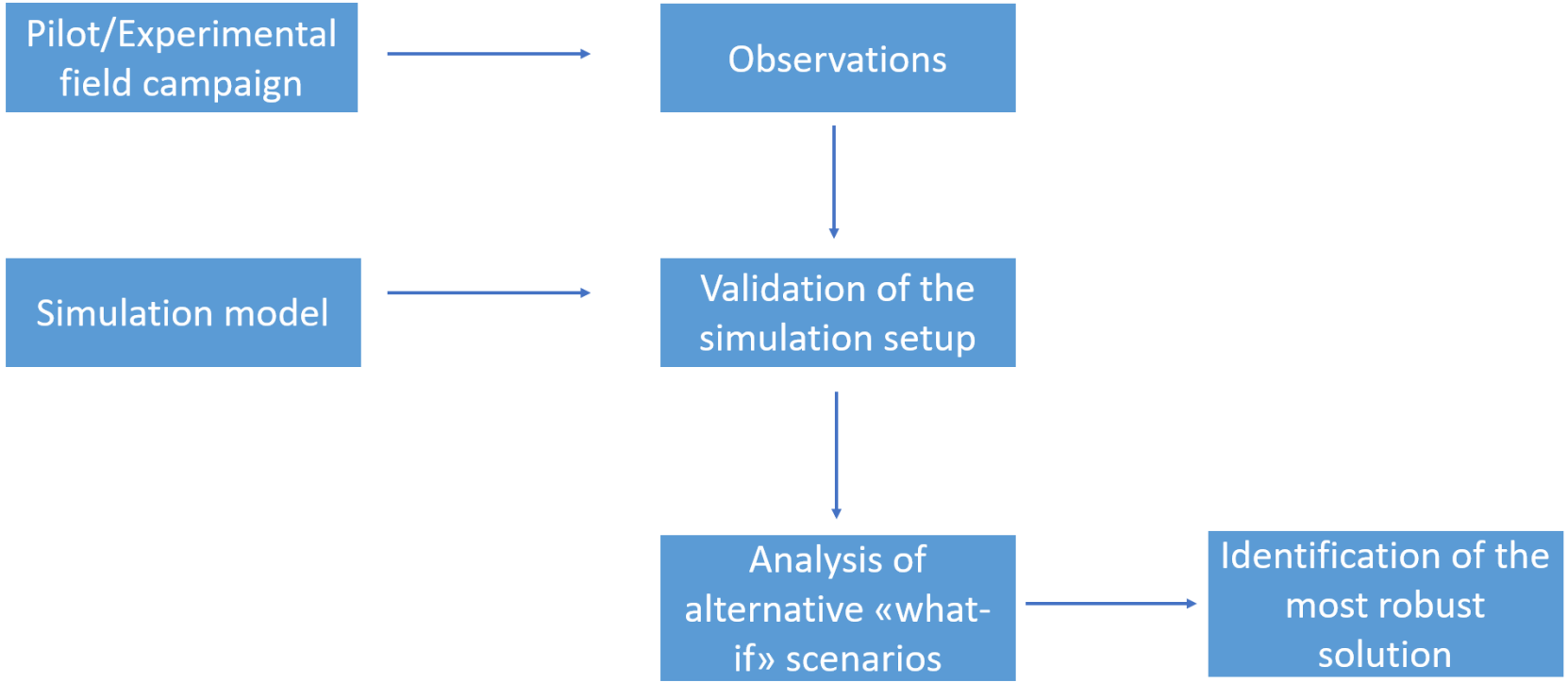
iSCAPE Project: https://www.iscapeproject.eu/

Additional Slides

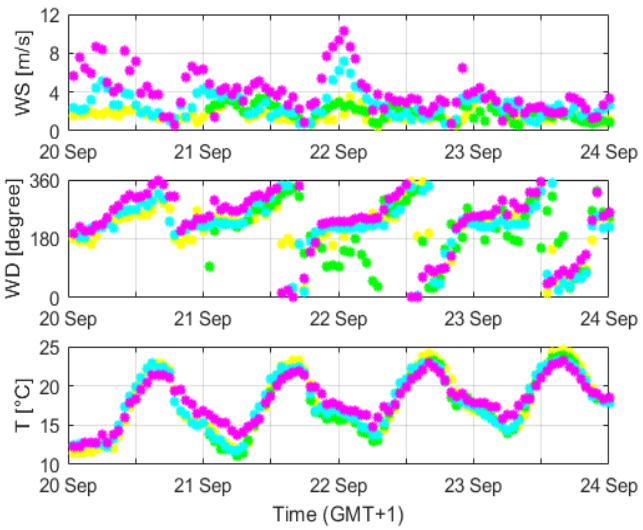
Key Findings and Recommendations

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

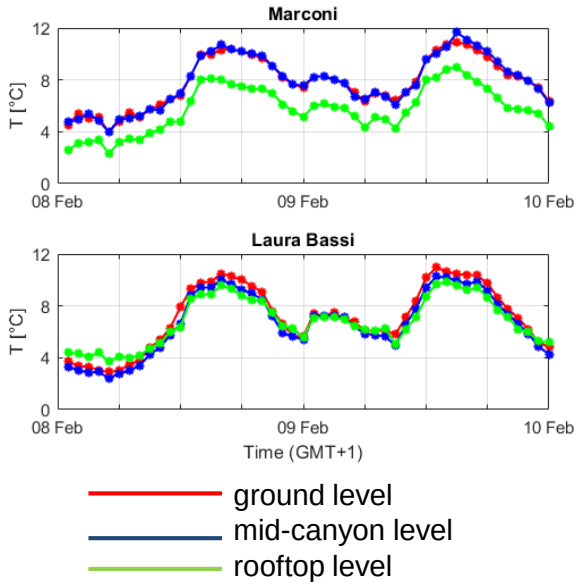
Multi-Scale & Multi-Approach Methodology



Trees in Urban Street Canyons: Analysis of Meteorology & Turbulence



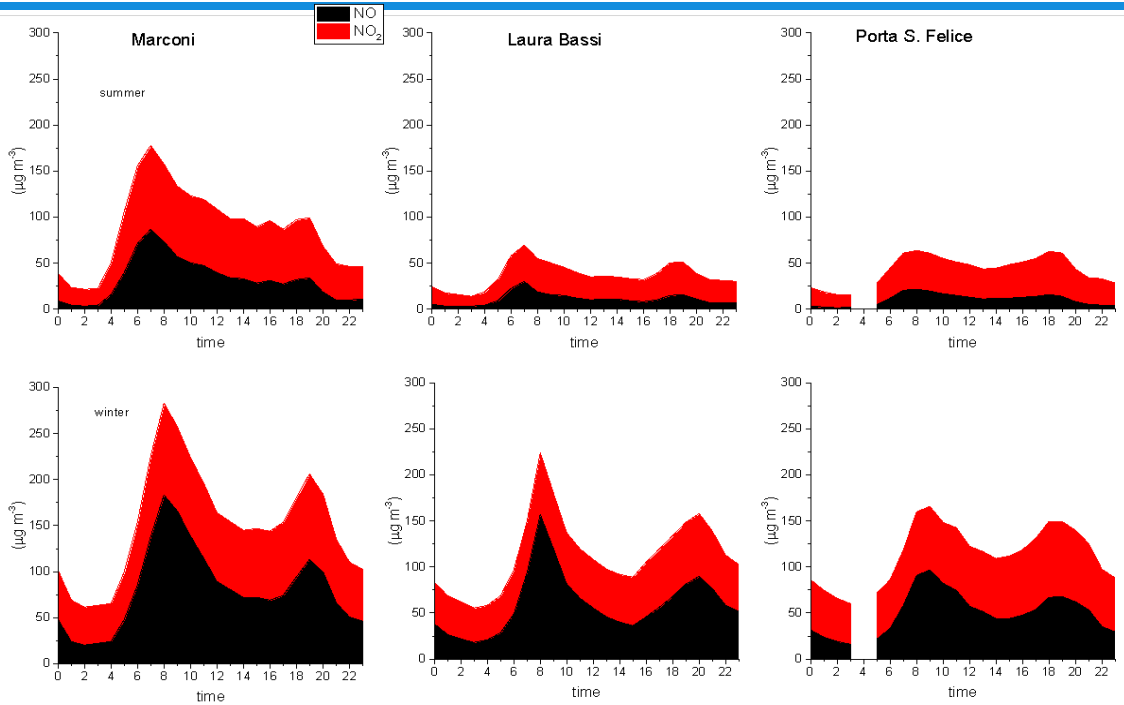
Pink dots: Torre Asinelli
Blue dots: Silvani Street
Green dots: Rooftop level Marconi
Yellow dots: Rooftop level Laura Bassi



Wind velocity: almost flat in time
Wind directions typically of thermal circulation with well-defined katabatic flow at night, and rotation during day
Typical diurnal summertime temperature pattern

Clear homogeneity in the signals inside and above the canyons

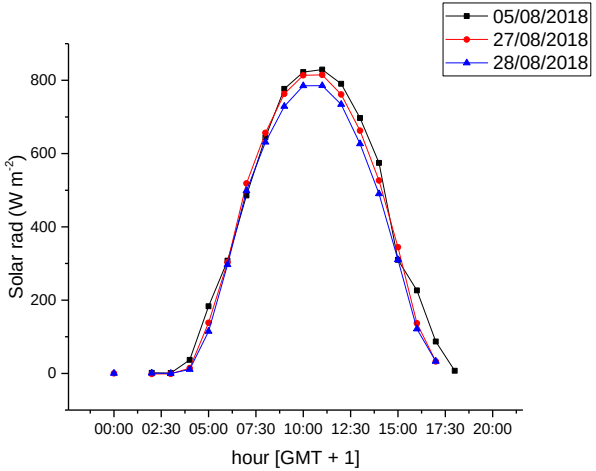
Trees in Urban Street Canyons: Air Quality

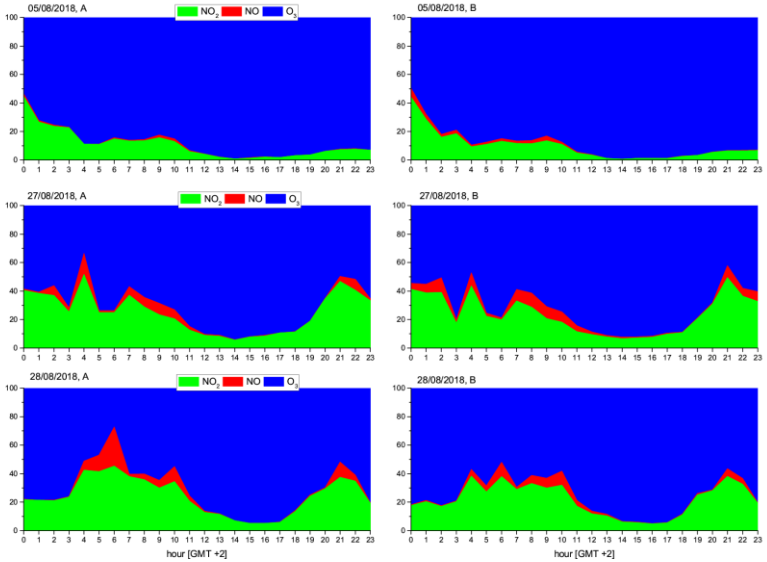


NO and NO_2 typical day

After emission by motor vehicles, the residence time of the NO component is too short to reach the street sides (where air quality measurements are carried out), except for Marconi Street

Photocatalytic Coatings: Analysis of NO_2-NO-O_3 Equilibrium Ratios



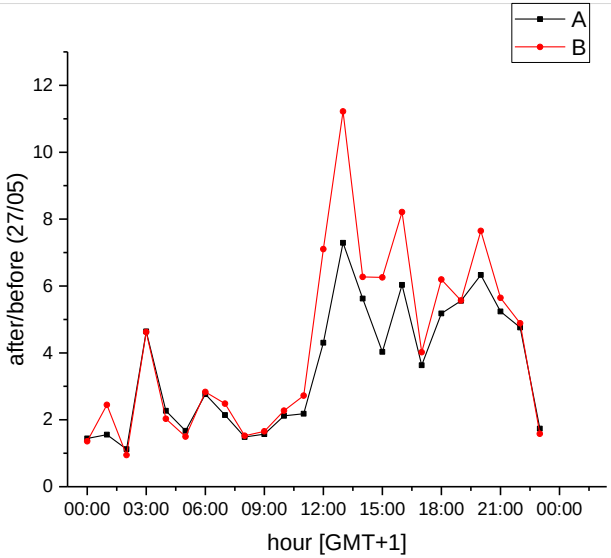


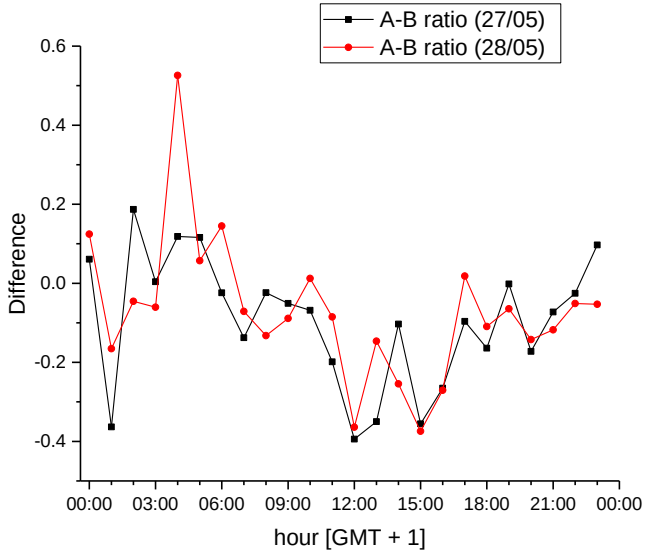
Identification of **similar** days before and after the painting of canyon A

- Similar solar radiation levels
- Weak synoptic forcing

- Similar diurnal and nocturnal patterns in the 2 canyons
- in both canyons during the days after the painting equilibrium moved towards O_3 destruction leading to an increase of NO_2 & NO levels

Photocatalytic Coatings: Analysis of NO_2-NO-O_3 Equilibrium Eatios



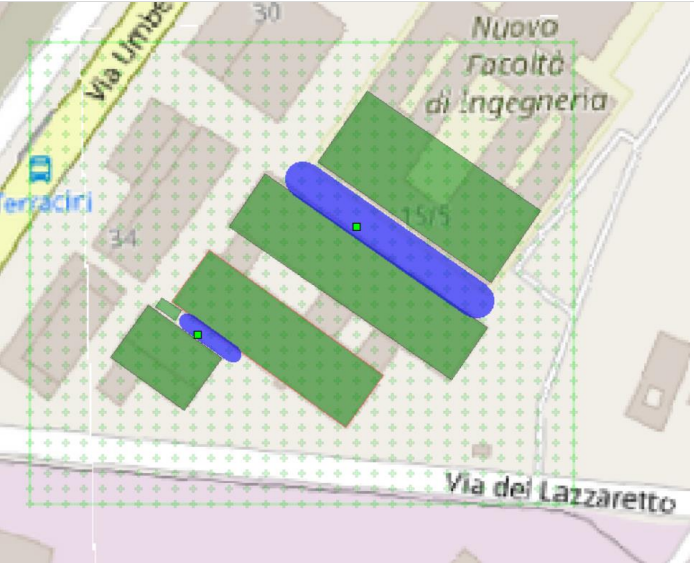


The ratios between NO_2 (or NO_x) concentrations after/before independent on meteorological conditions (same over the two canyons) and canyon geometry (same in the 2 periods), as indicated by the similar pattern in the 2 canyons

Differences in the ratios in the 2 canyons depend on other differences (the coatings):

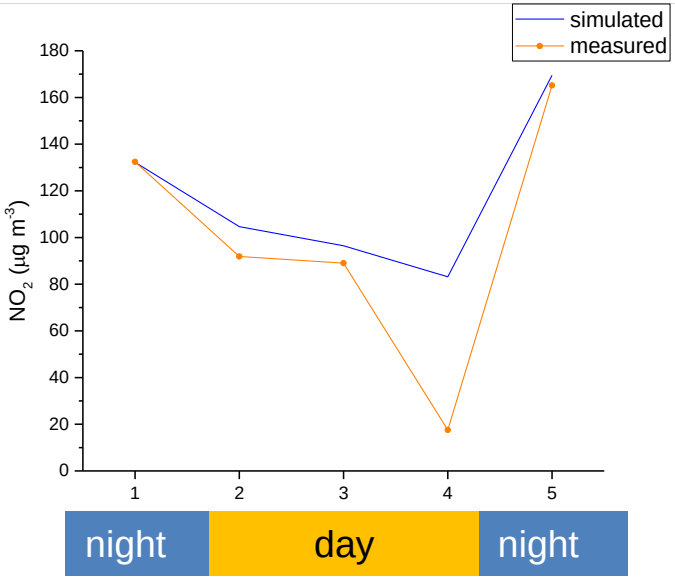
- Mostly negative during daytime
- Null or positive during nighttime (no UV light)
- Efficiency **13-17%** on **NO_2 (15-21% NO_x)**

Photocatalytic Coatings: ADMS Simulations



Geometry of the main buildings and of the two canyons considered in the setup of the ADMS-Urban simulations

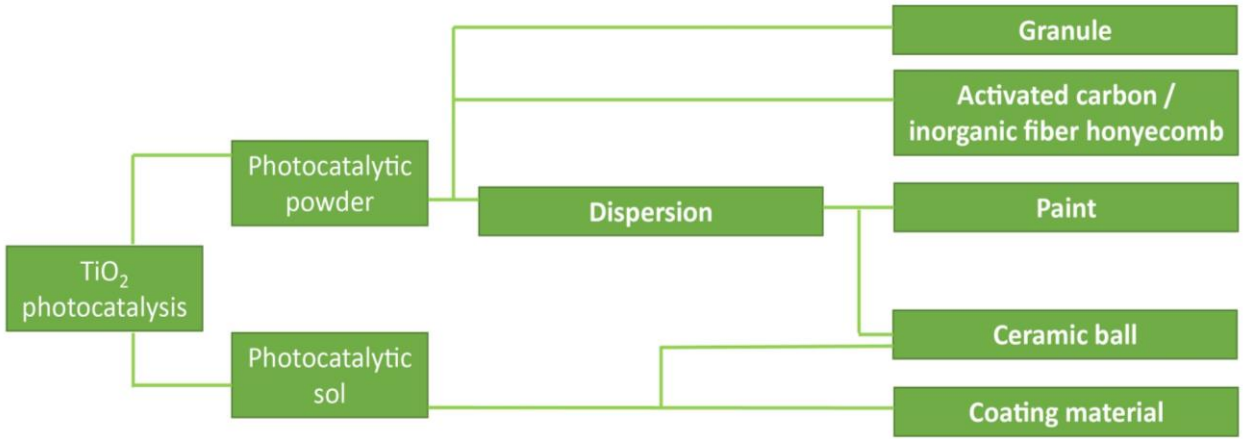
5 simulations during controlled pollutant release experiments



The simulations agree well with the observations at night (no activation) but overestimates the concentrations observed during day

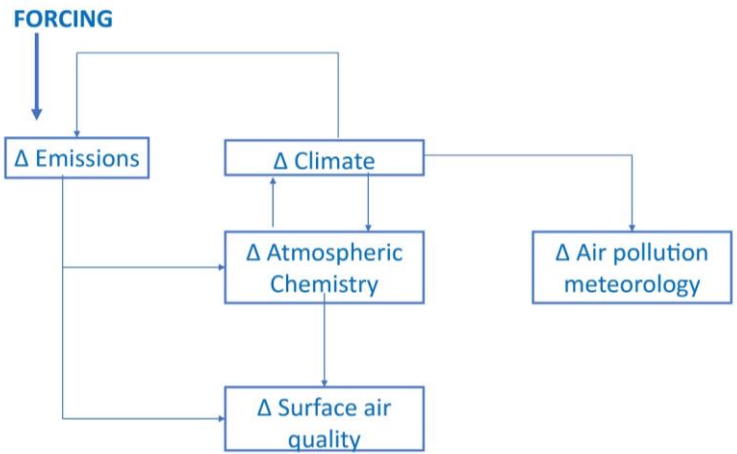
Efficiency **8-13% NO_2 (15-21% NO_x)**

Recommendations: Photocatalytic Coatings

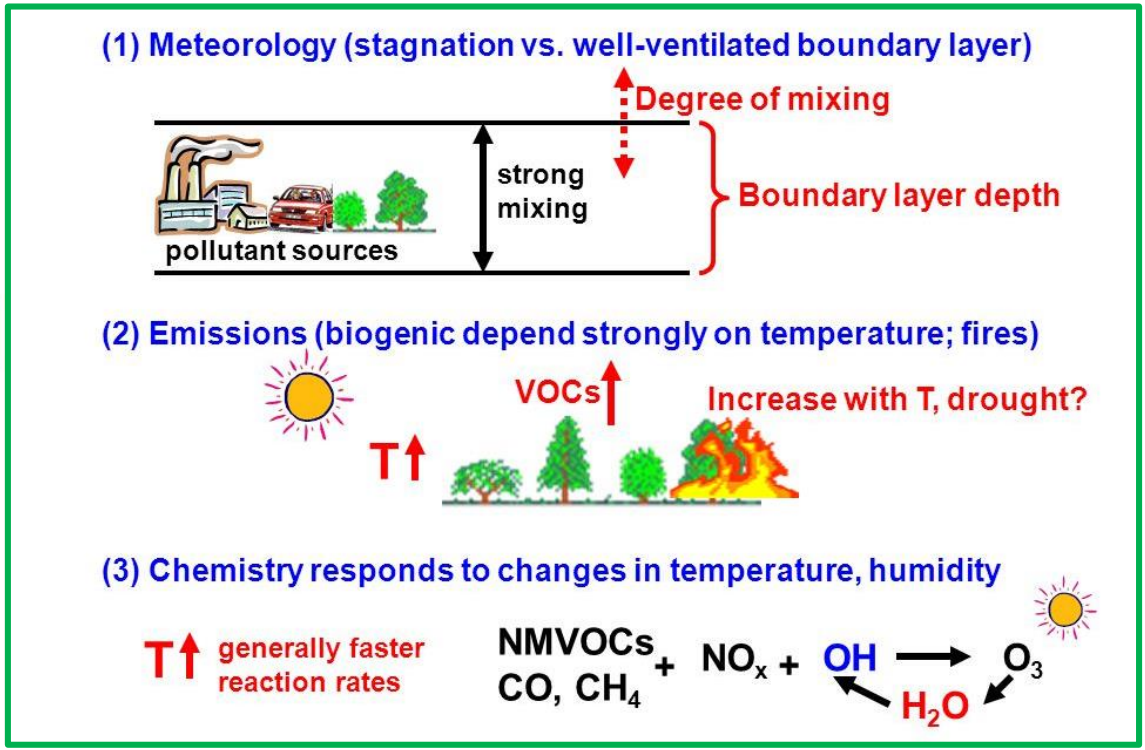


Main characteristics
Coating applicability
Durability
Adherence (to concrete tiles)
Performance (NOx and VOC reduction)
Photoactivity and response to visible/UV-light
Deposition method

Interactions between Air Pollution & Climate Change



From Jacob and Winner, 2009



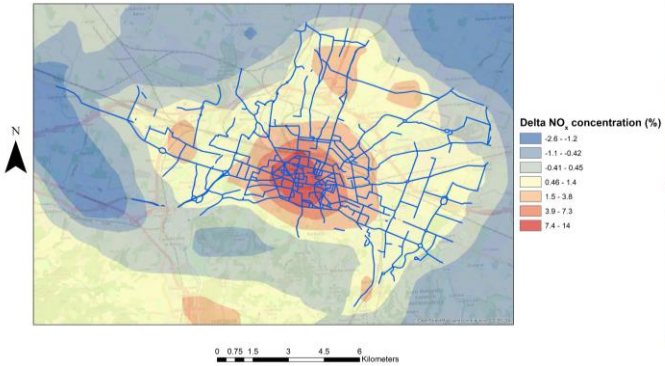
Interactions between Air Pollution & Climate Change

- **Short lived climate pollutants** (SLCPs), such as black carbon and ozone, can **exacerbate climate change**, altering the frequency, duration, and location of heat waves and cold spells, storm intensity, precipitation patterns, and, possibly, ultra-violet radiation exposure, indirectly threatening urban lives and livelihoods (Mitchell et al., 2016).
- A **warmer** climate can have an **impact on biogenic volatile organic compound** emissions, the rate of atmospheric chemical reactions, and the depth of the atmospheric boundary layer, all affecting surface pollutant concentrations (Heal et al., 2013).
- Changes in meteorological variables can **modify global sea level pressure patterns**, with consequences on **local circulations and distribution of air masses** (iSCAPE D1.4).
- **Climate change** induced by enhanced pollutant emissions will **in turn increase pollutant concentration** (iSCAPE D1.4).
- A **positive feedback** is established, leading to an intensification of climate change in those regions highly affected by air pollution (iSCAPE D1.4).

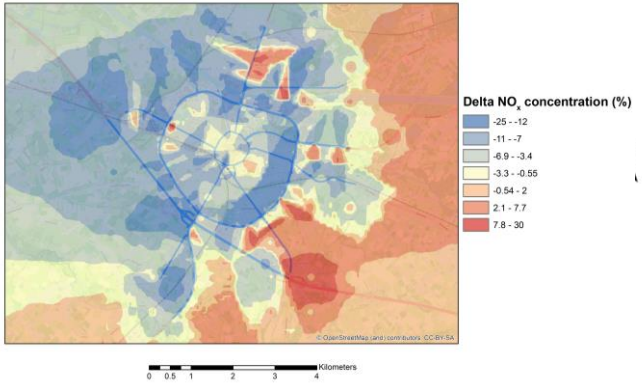
Interactions between Air Pollution & Climate Change

NOx

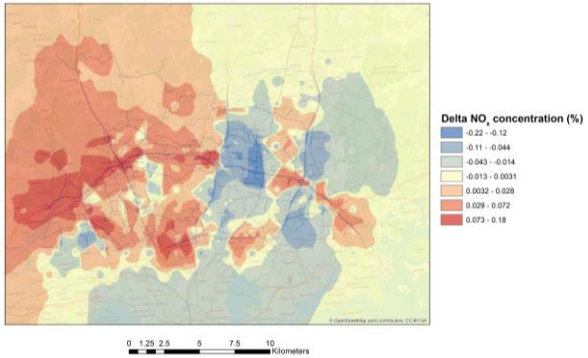
Southern EU



Central EU



Northern EU



Together with the difficulties and uncertainties previously indicated when estimating the net effect of NO_x on climate, these spatially-varying changes make it very hard to estimate the impact of air quality on climate change in the future