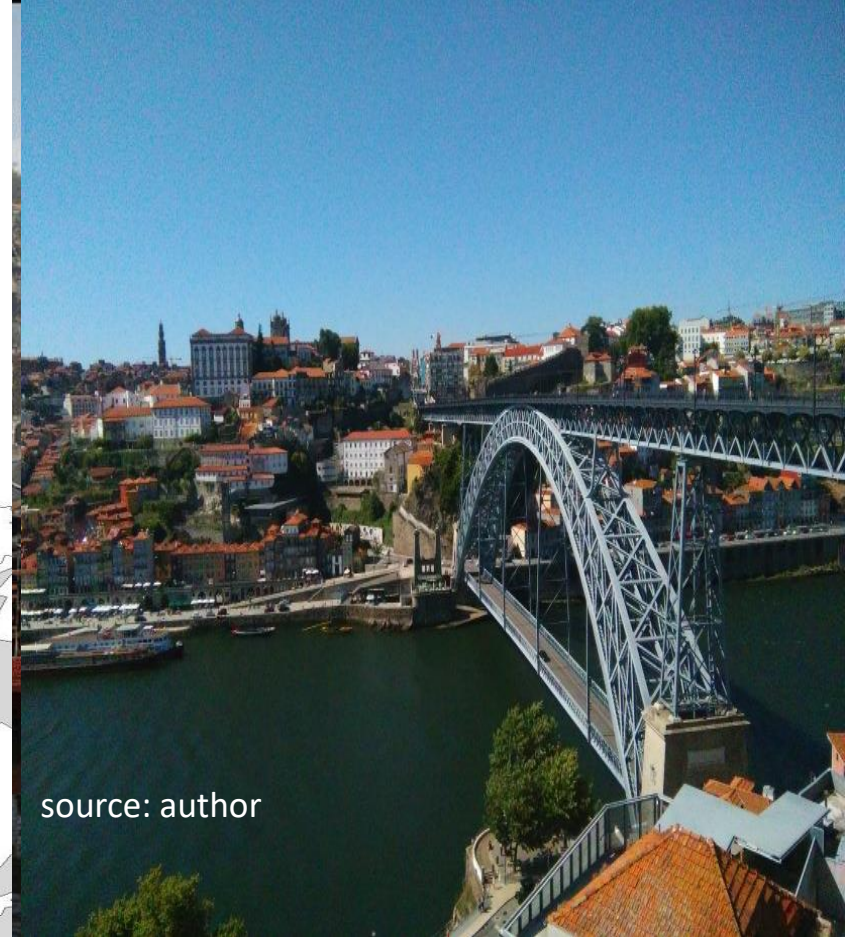
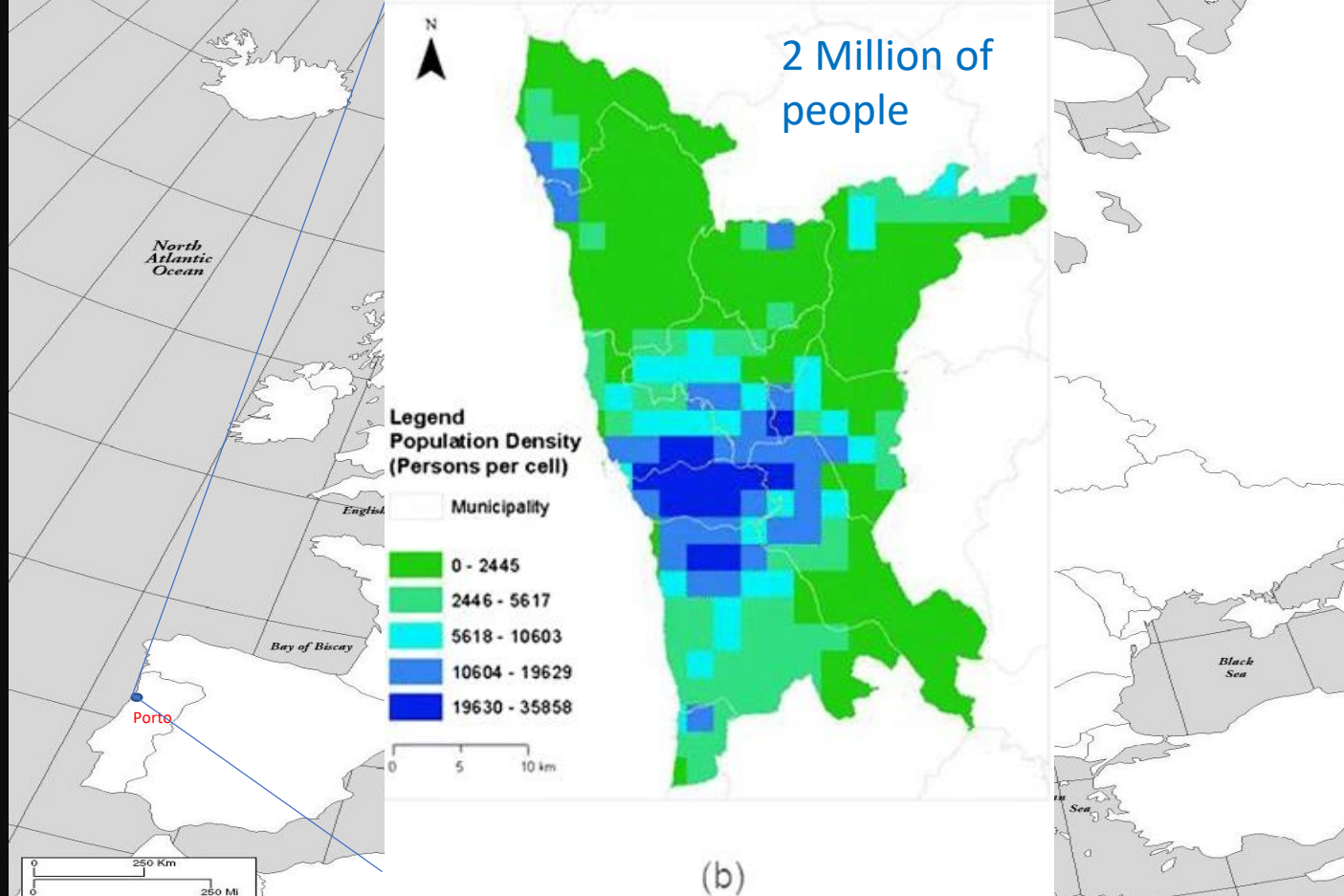




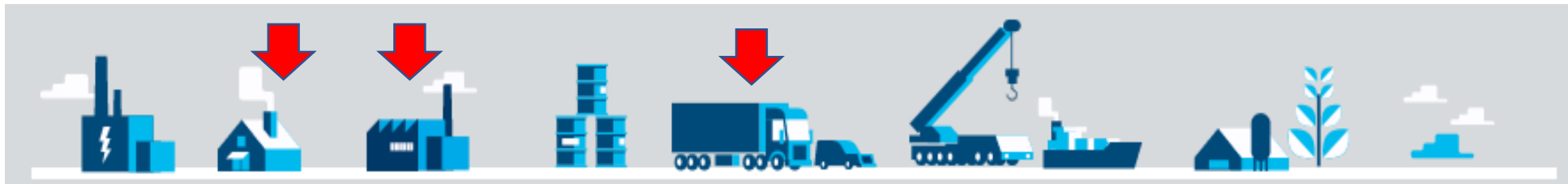
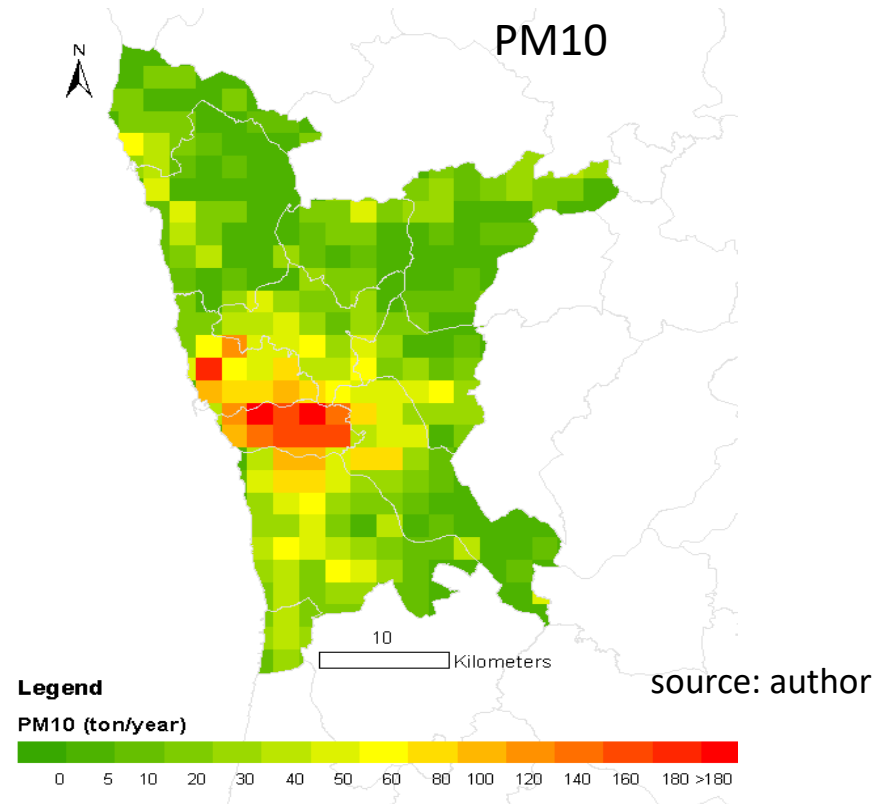
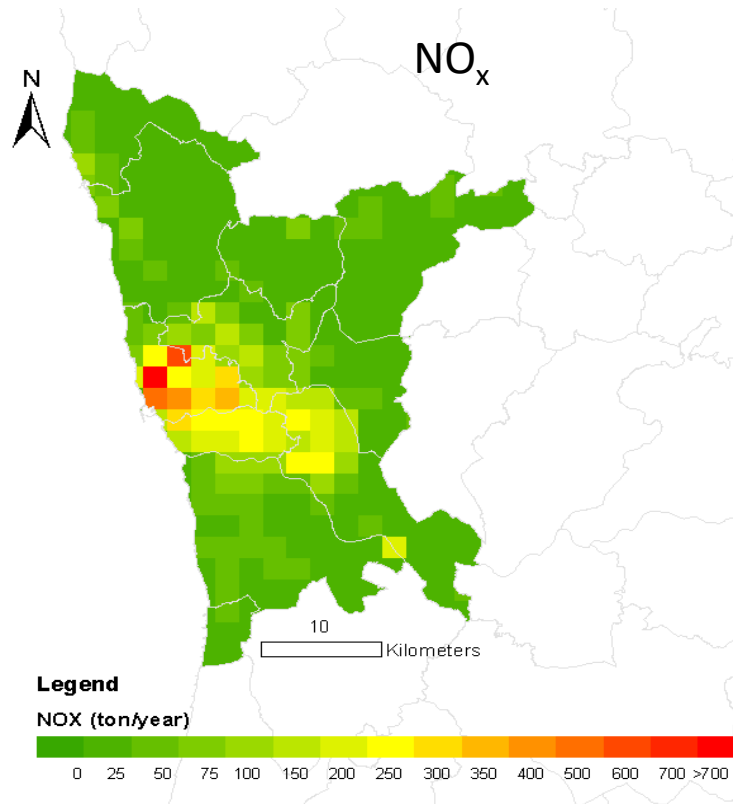
Evaluating strategies to reduce urban air pollution in Porto, Portugal

Hélder Relvas, Alexandra Monteiro & Ana Isabel Miranda
Department of Environment and Planning



Case study: Porto urban area

Major PM10 and NO_x emission sources

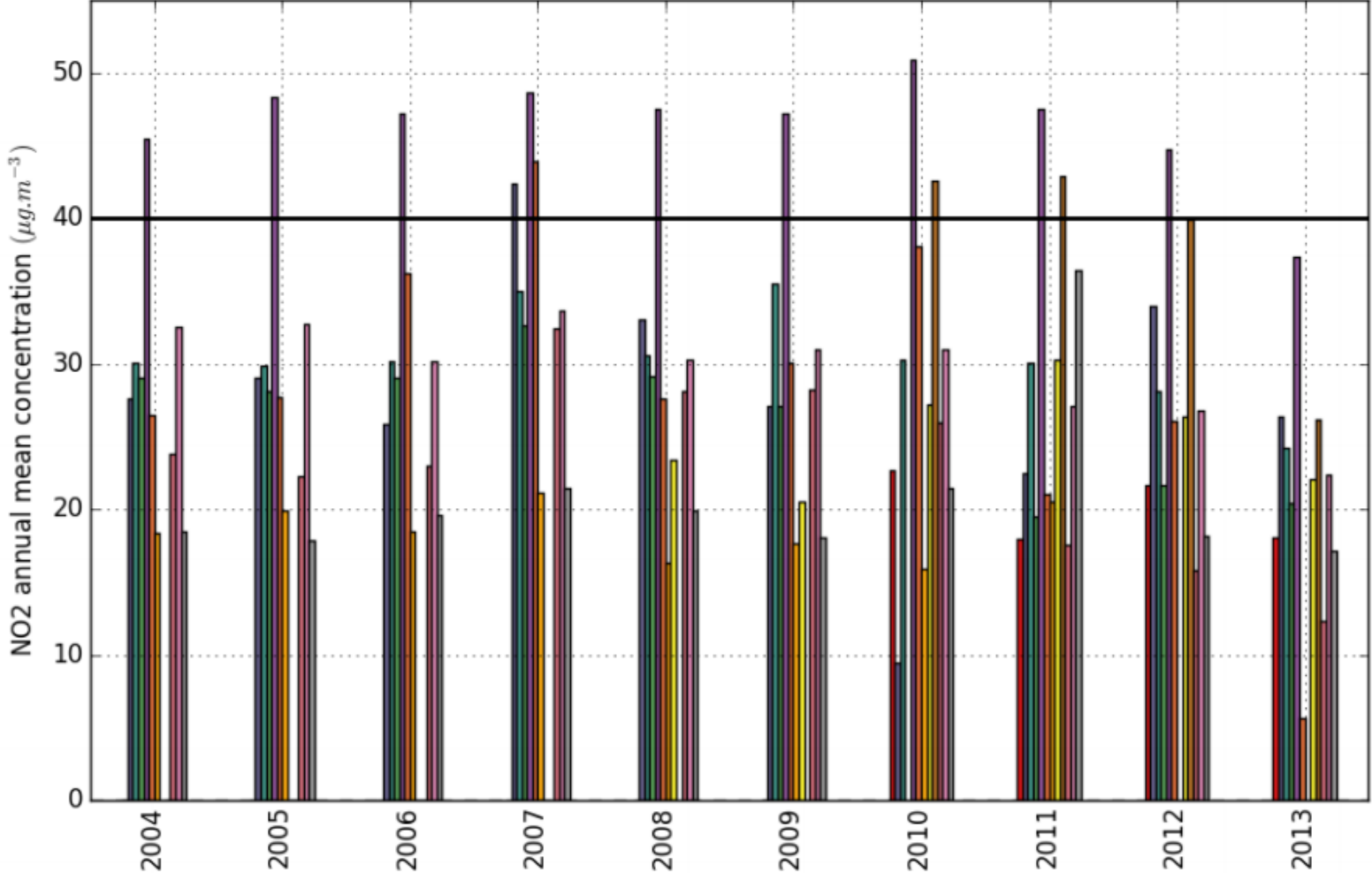


Air pollution episodes

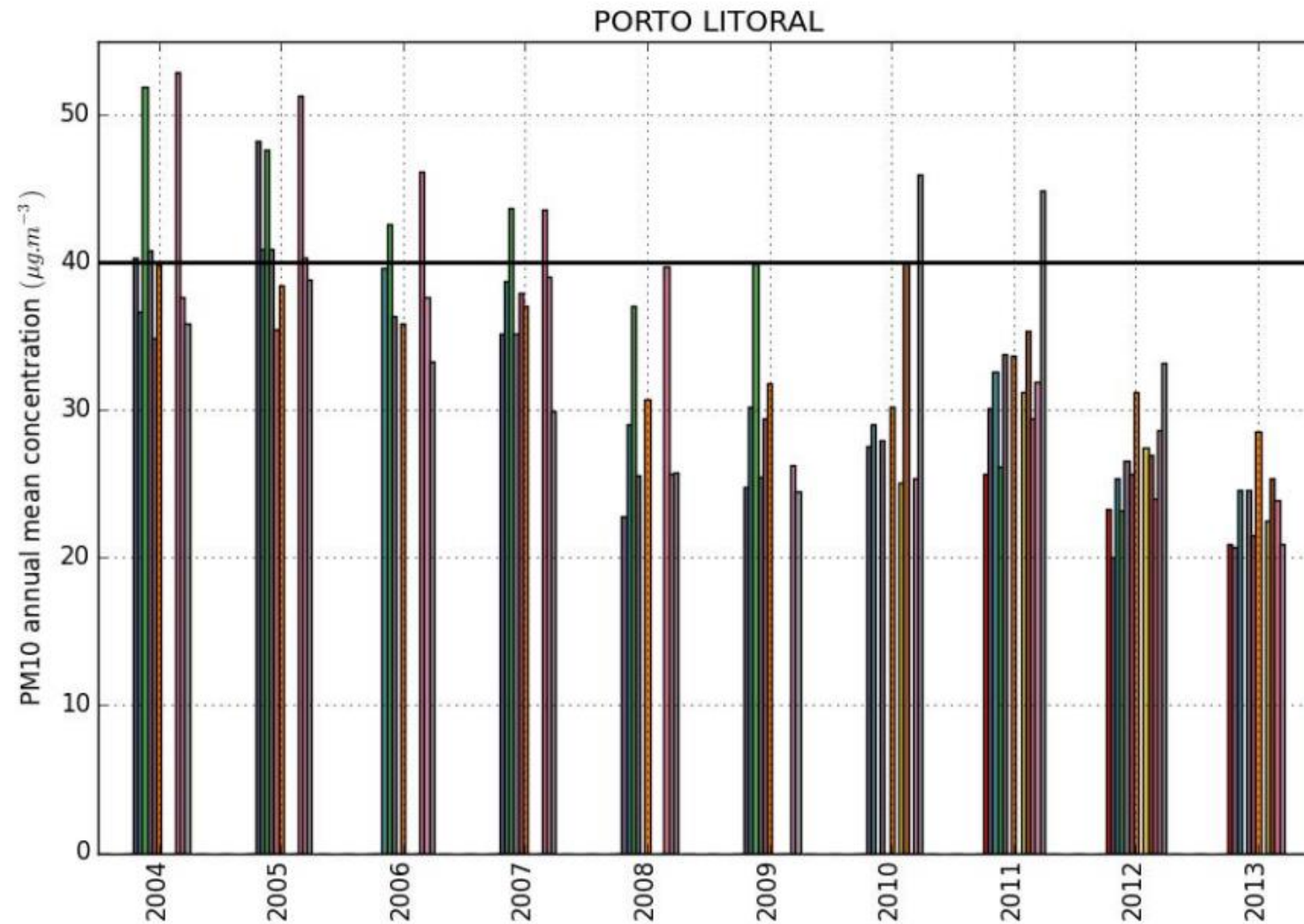
Porto urban area

- exceedances-
- air quality plans-

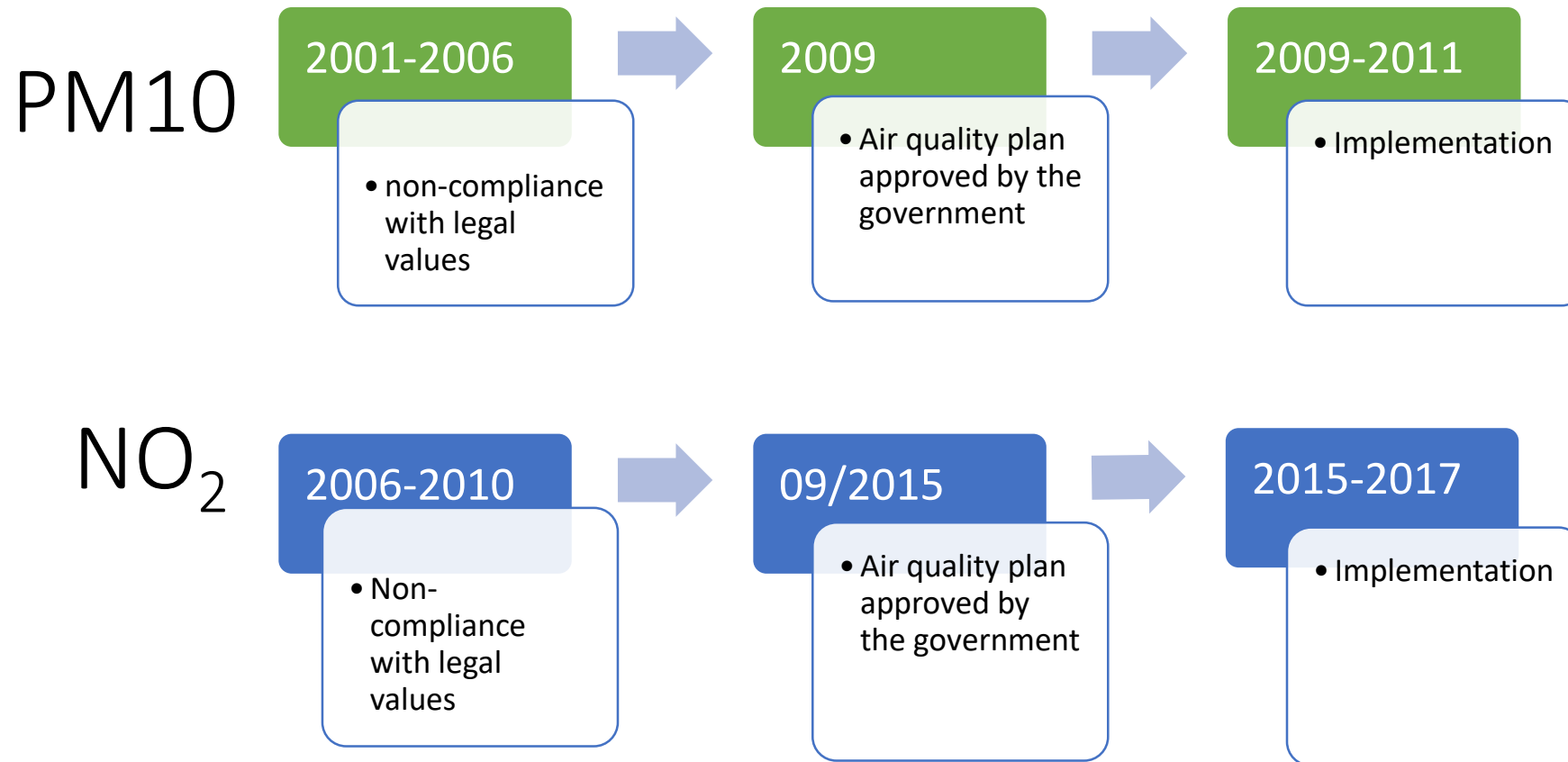
NO₂ annual mean concentrations in Porto air quality stations



PM10 annual mean concentrations in Porto air quality stations



Timeline: Air quality plans



The Norte Portugal Regional Coordination and Development Commission (CCDR-N) established several protocols with municipalities and public entities

Some of the measures included in the Air Quality Plans

- Incentives for renewing the fleet of heavy passenger vehicles
- Car sharing
- Renovation of Solid Municipal Waste Collection fleets
- Improvements in the public transport network
- Street cutting to traffic
- Study of Low Emission Zones
- Increase of cycling routes
- Reinforcement of inspection of industrial sources
- Reinforcement of the inspection of illegal parking
- Increase of Natural Gas stations
- Promotion of the implementation / improvement of gaseous effluent cleaning systems in industries
- ✘ • Reduction of emissions from residential combustion
- Street washing
- Dust reduction for civil construction works
- Environmental awareness - communication plan



Air quality in Porto

- research projects-
- evaluating strategies-
- impacts on human health-

Research projects that had Porto as a case study

APPRAISAL— Air Pollution Policies for
Assessment of Integrated Strategies At regional
and Local scales



MAPLIA – Moving from Air Pollution to Local
Integrated Assessment



CLICURB - Urban atmospheric quality, climate
change and resilience

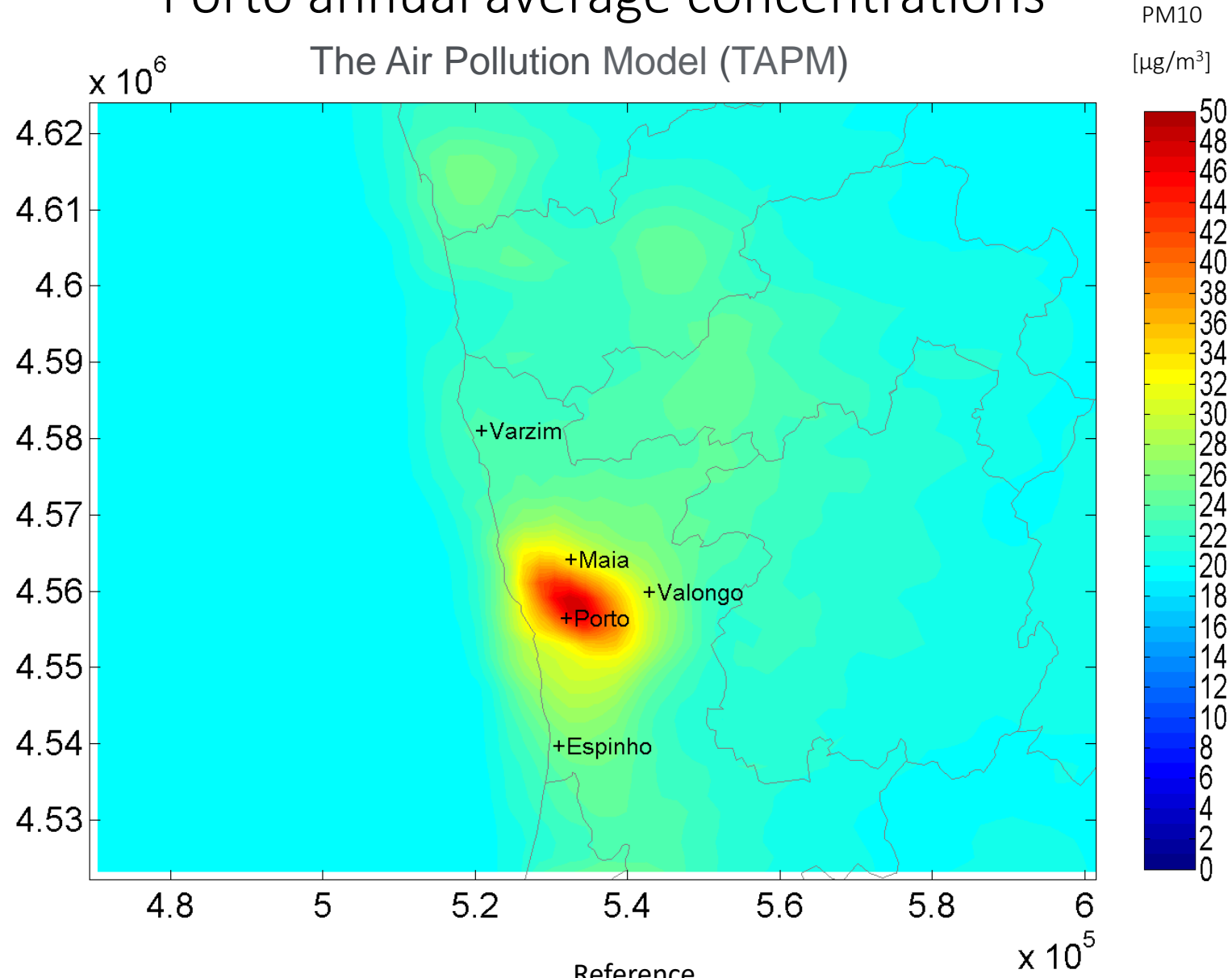


LIFE INDEX-AIR - Development of an Integrated
Exposure – Dose Management Tool for
Reduction of Particulate Matter in Air



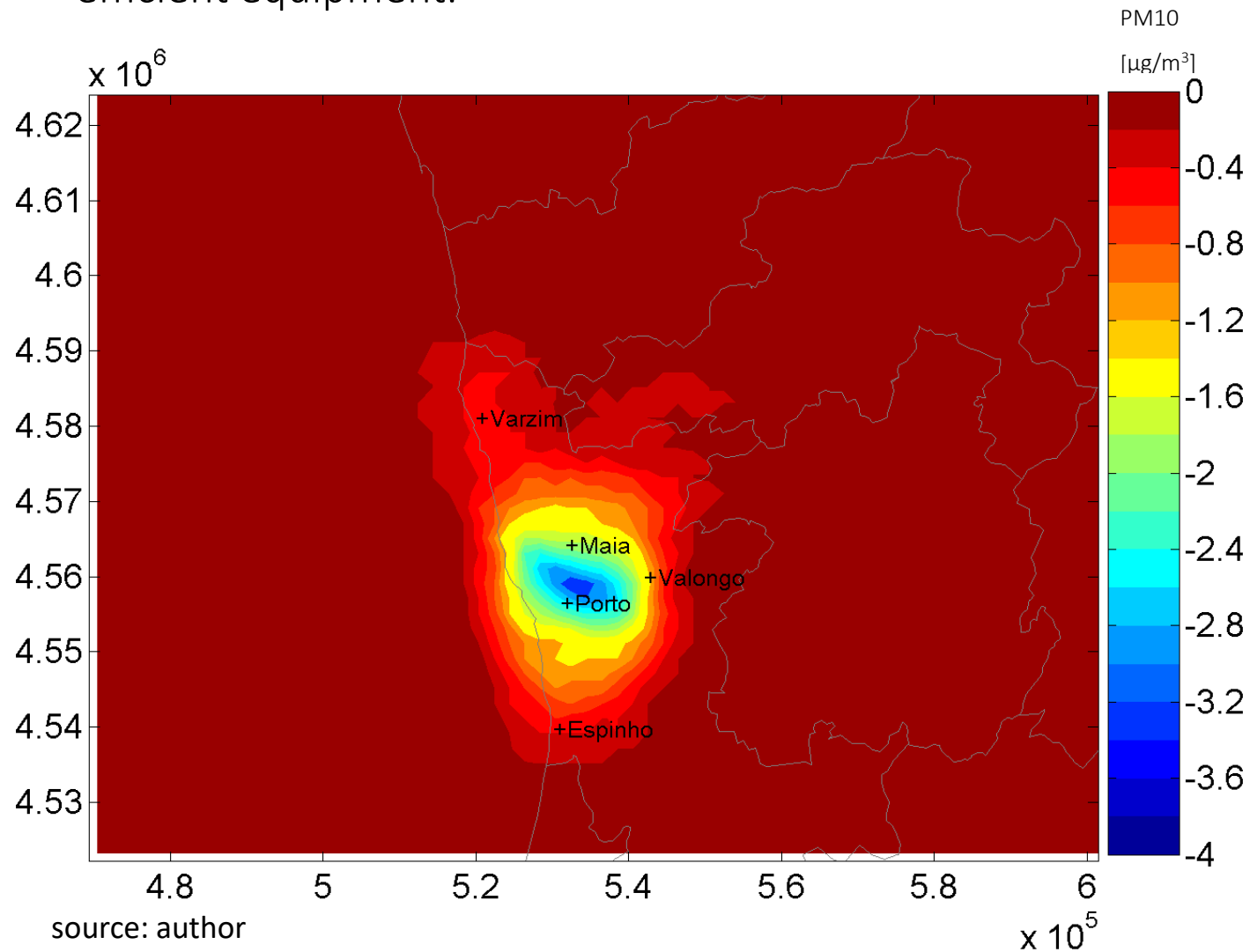
Porto annual average concentrations

The Air Pollution Model (TAPM)



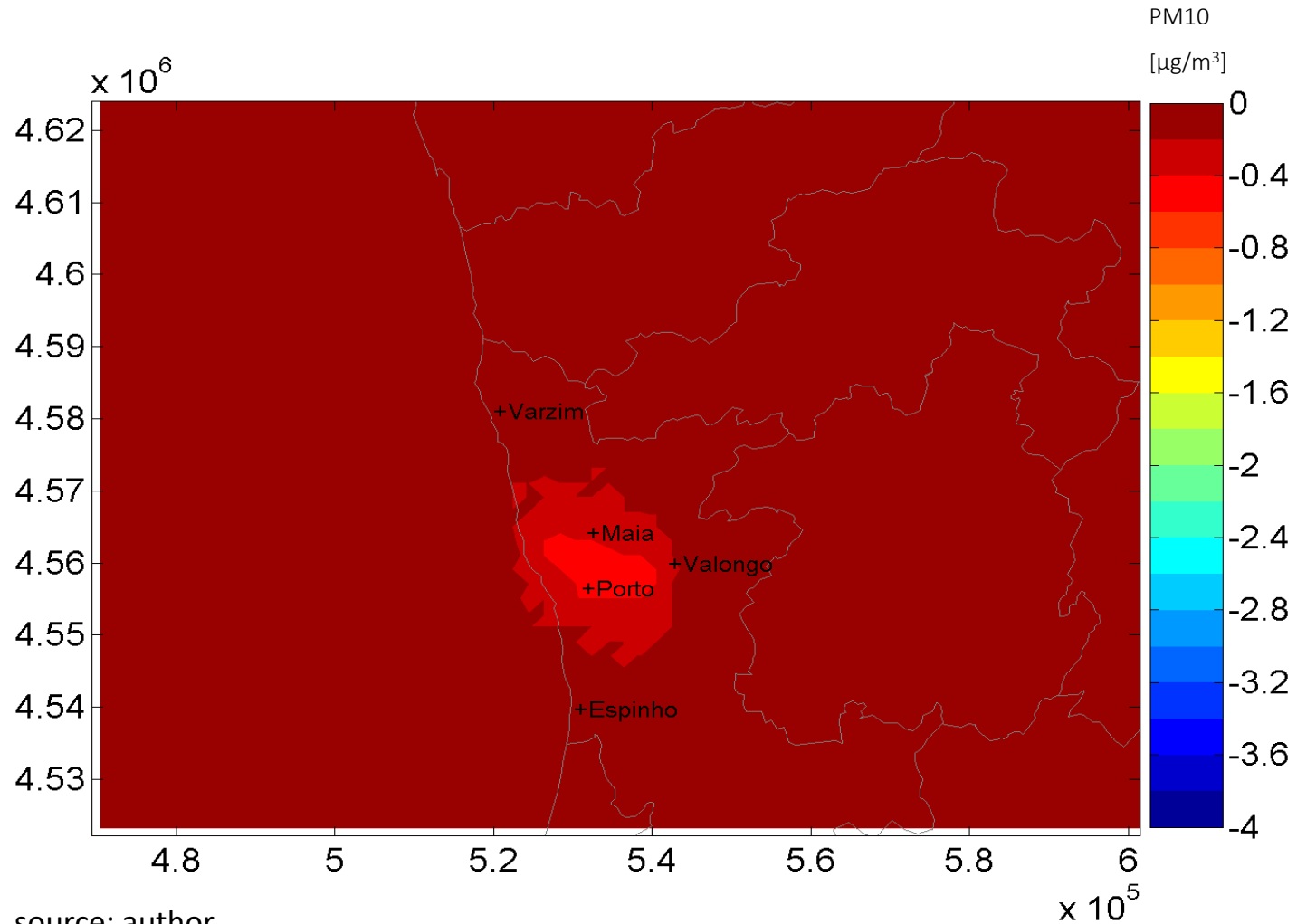
Reduction scenario

1 - Replacement / conversion of 50% of conventional fireplaces with more efficient equipment.



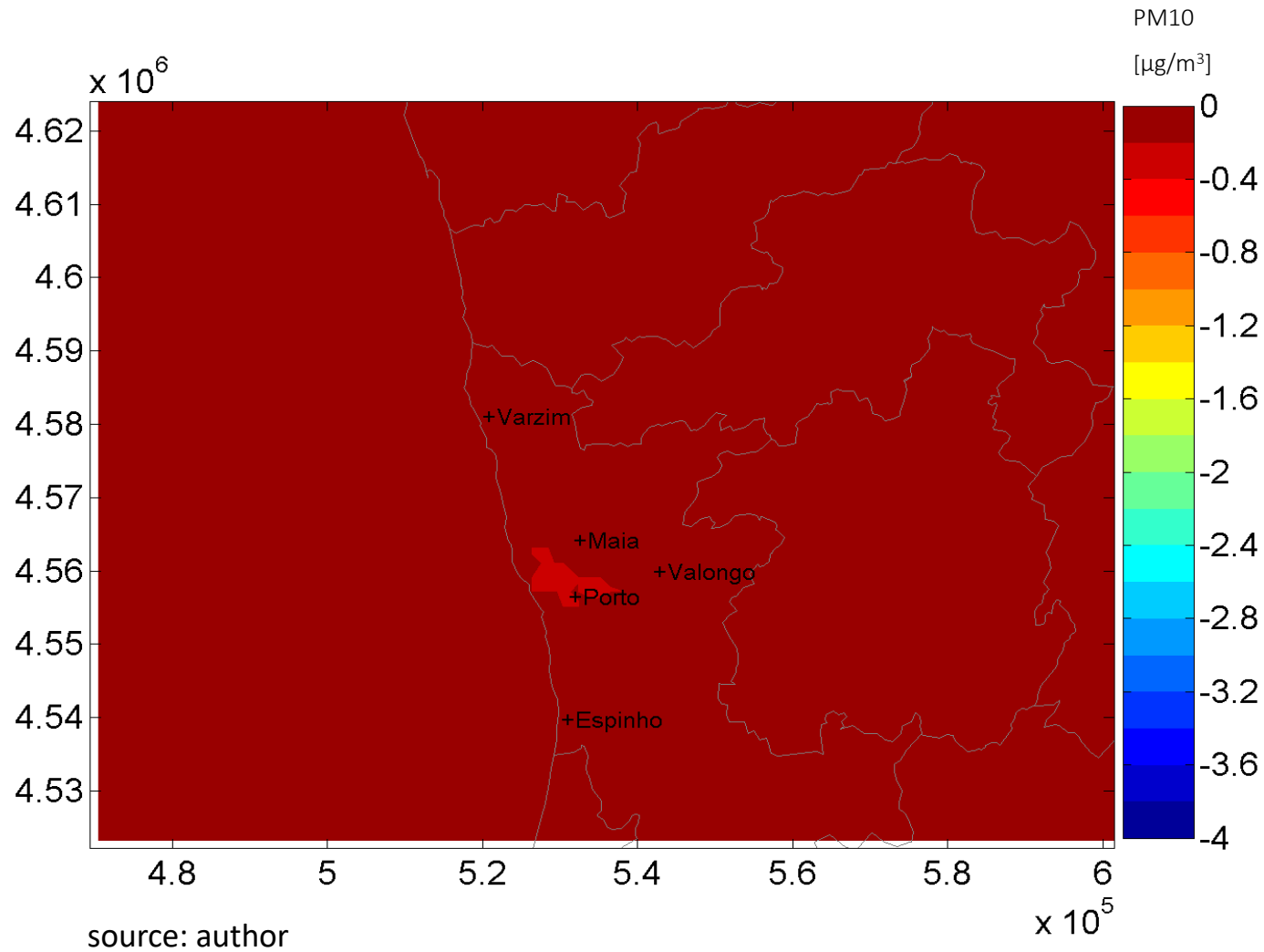
Reduction scenario

2 - Application of technologies (high efficiency dedusting), which allows for an additional 5% reduction in PM10 industrial emissions.

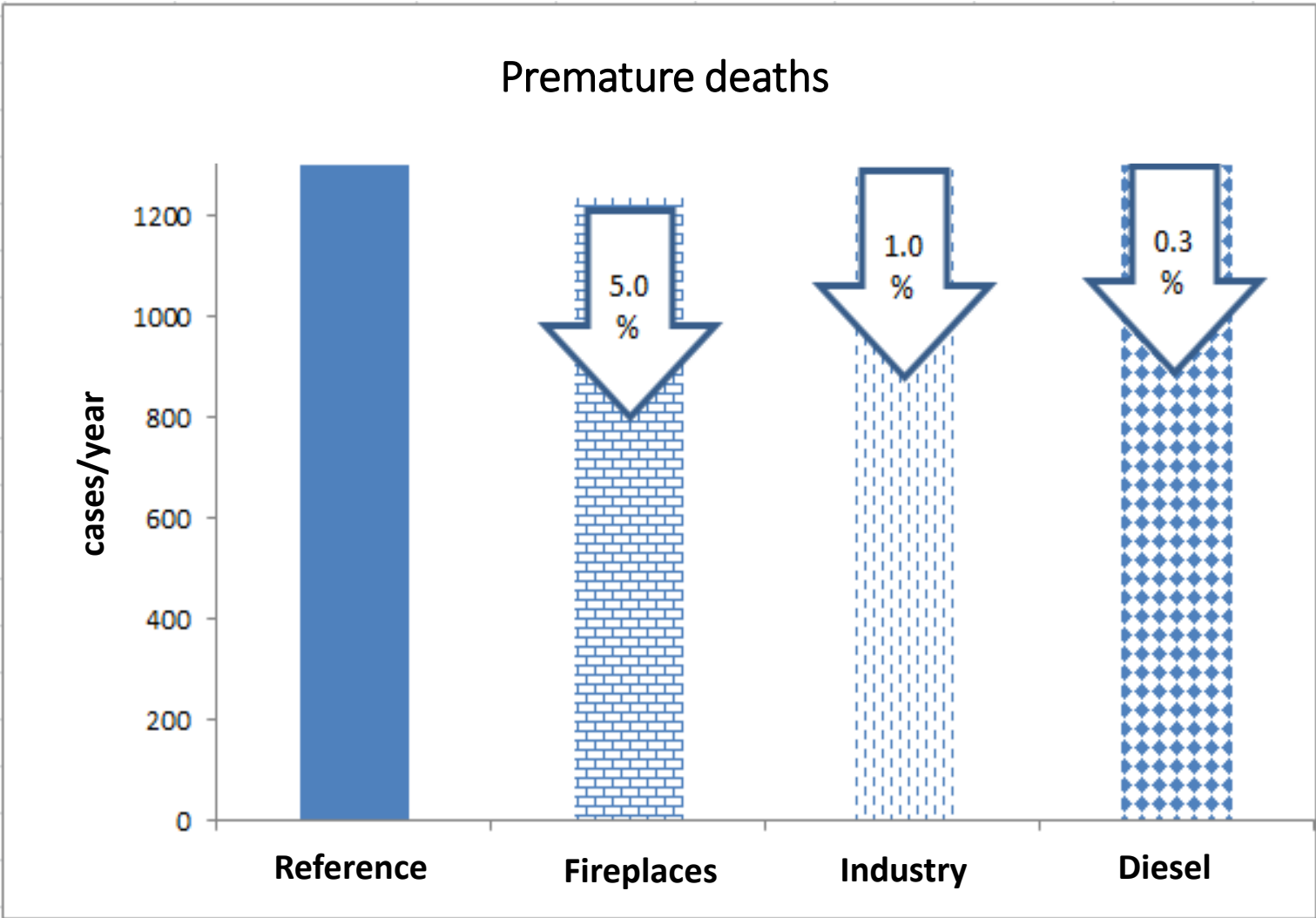


Reduction scenario

3 - Banning light diesel passenger vehicles from the municipality of Porto.



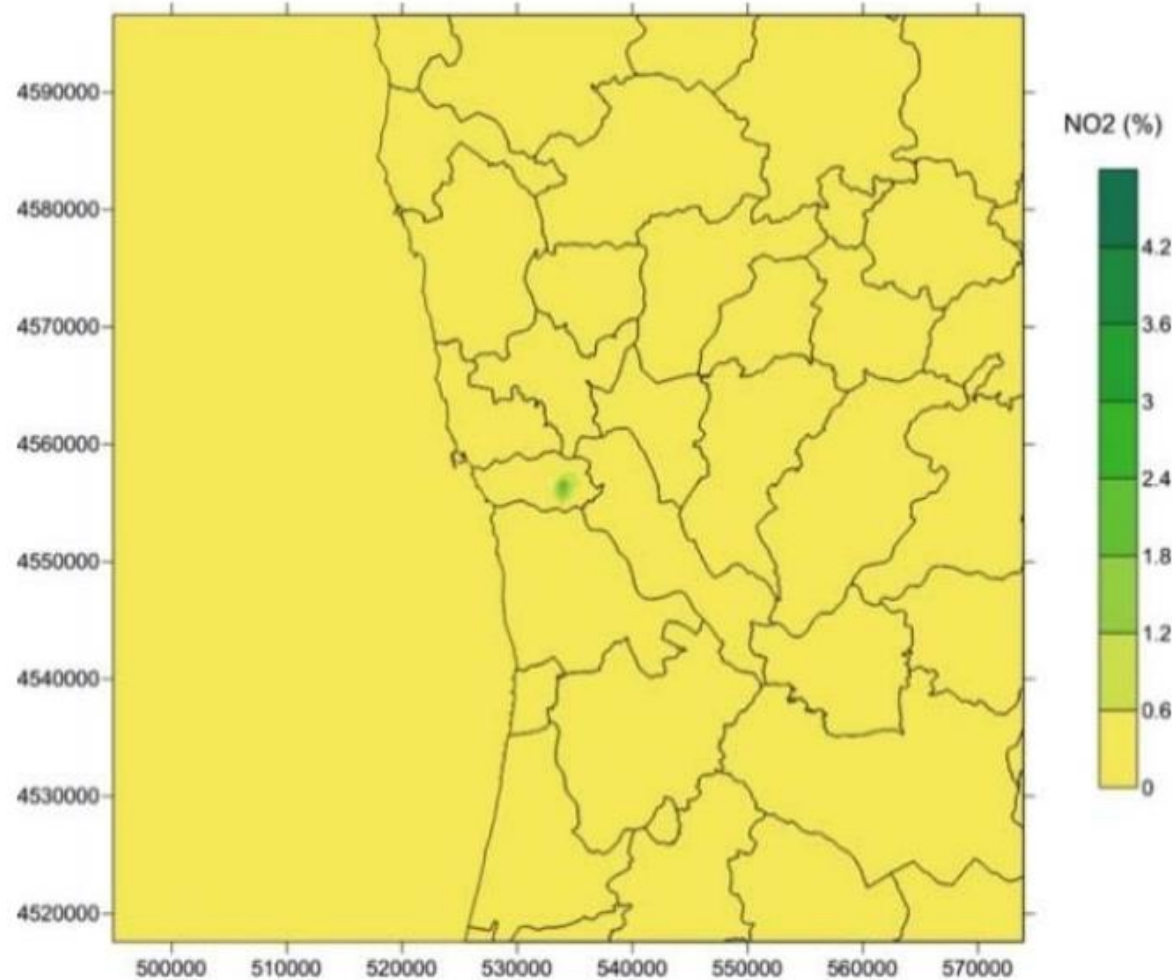
Health effects



Health risks of air pollution in Europe – HRAPIE project
Recommendations for concentration–response functions

source: author

Evaluation low emission zone (vehicles below EURO3)



source: author



The effects are only felt in the influence area of the proposed LEZ.

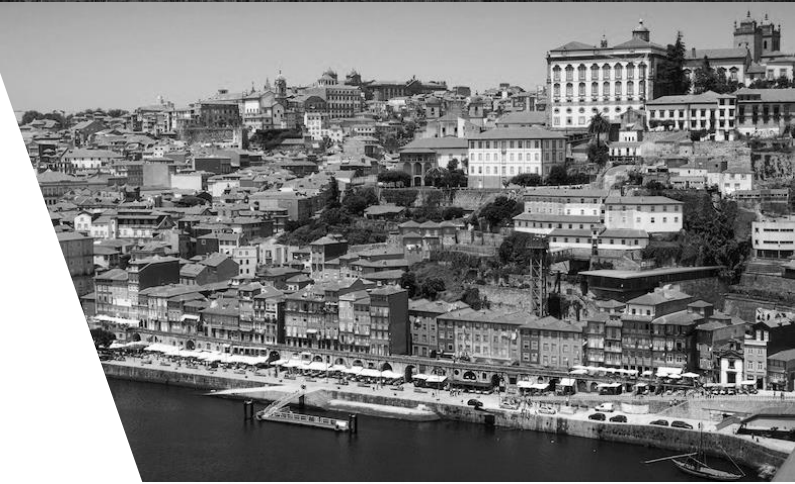
Other mitigation measures: Green infrastructures (GI)

(parks, gardens, green roofs and walls, grass verges and street trees).

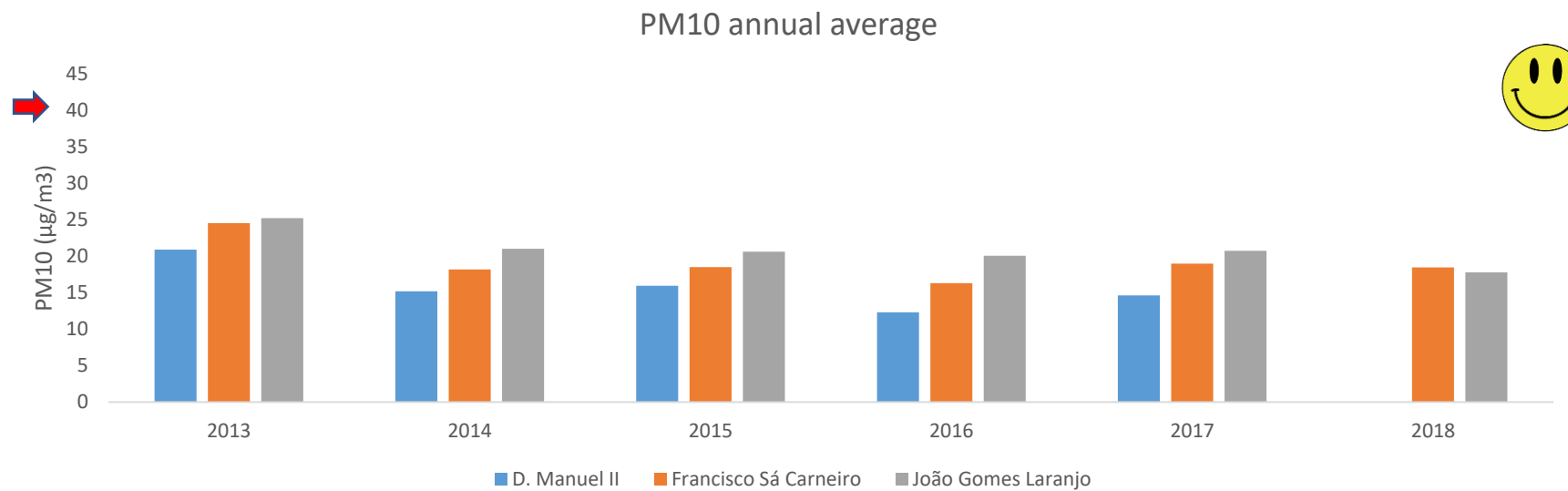
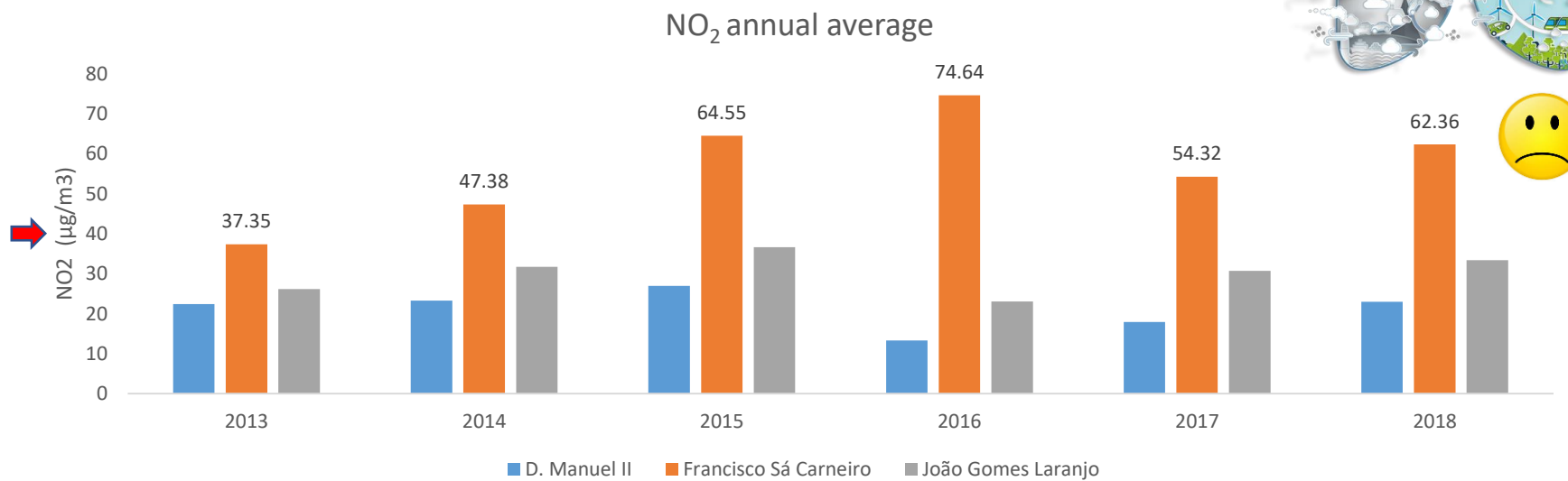
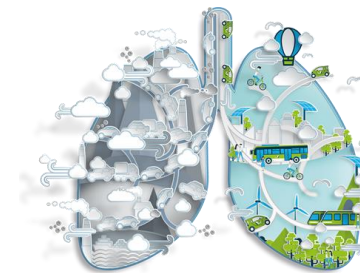
Green infrastructures has a role to play in **creating attractive environments** that incentivize active travel, such as walking and cycling.

Control air pollution dispersion. Using GI to create vegetation barriers that reduce the public's exposure to what is emitted.

CFD models



Porto air quality levels



Health impacts of air pollution

-AirQ+: software tool for health
risk assessment of air pollution-

Health impact, by AirQ+

$$HI_{(p)} = \sum_{i=1}^n [(pop_{(p,i)} \times Inc_{(i)}) \times RR_{(p,i)}]$$

Population data

incidence/prevalence rate

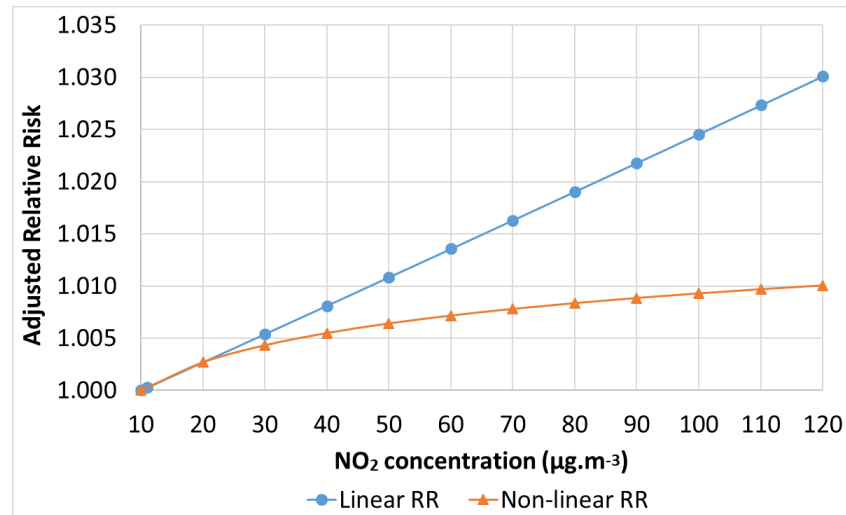
Relative Risk

Linear

$$RR = \exp[\beta (X - X_0)]$$

Non-linear

RR



RR_(p,i) correlates a pollutant p's concentration variation (X - X₀) with the probability of experiencing or avoiding a specific health indicator i;

β coefficient – Concentration-Response Function - change in the RR for unit change in concentration X (expressed as the natural logarithm of RR);

X is the pollutant p's concentration (µg.m⁻³): daily values to calculate the short-term exposure risk, or annual averages if long-term RR is required;

X₀ - pollutant p's cut-off or counterfactual concentration value (µg.m⁻³) above which health impacts are calculated.

Health impact, by AirQ+ - challenges, limitations and solutions

Challenge:

Estimate health impacts of air pollution for a local/ urban/ regional scale area of interest

Various locations (e.g. air quality modelling/monitoring results)

Various pollutants (PM, O₃, NO₂)

Various health indicators (mortality and various morbidity indicators)

AirQ+ limitations:

for **each air pollutant and health indicator a separate impact evaluation has to be carried out**, implying intensive work to conduct a complete HIA with all the available pollutants and health indicators.

Our solution was:

Develop a python script with AirQ+ equations and related data adapted to read air quality modelling outputs and compute health impacts by pollutant

Application at local (CFD model) and regional scale (CAMx model)



source: author

Conclusions

- **Citizen's attitudes and behaviors are crucial to keep air quality levels below limits in Porto's urban area**

PM10 and NO₂ concentration levels depend on the:

- meteorological conditions
- structure of the local urban area
- emissions from road traffic and residential combustion

Air quality need to be achieved in an integrated mode



Thank you!

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