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Modelling the Impacts of Mobility on Urban Air Quality and Health: Scenario Analysis for the Barcelona Metropolitan Area (Metropolitan Mobility Plan-PMMU)

Carles Conill[1], Elena Domene, Marta Garcia, Joan Marull, Maite Pérez[2]

[1]Barcelona Metropolitan Area (AMB), Barcelona, Spain
[2]Barcelona Institute of Regional and Metropolitan Studies (IERMB), Cerdanyola del Vallès, Spain

AMB Àrea Metropolitana de Barcelona

iermB INSTITUT D'ESTUDIS REGIONALS I METROPOLITANS DE BARCELONA

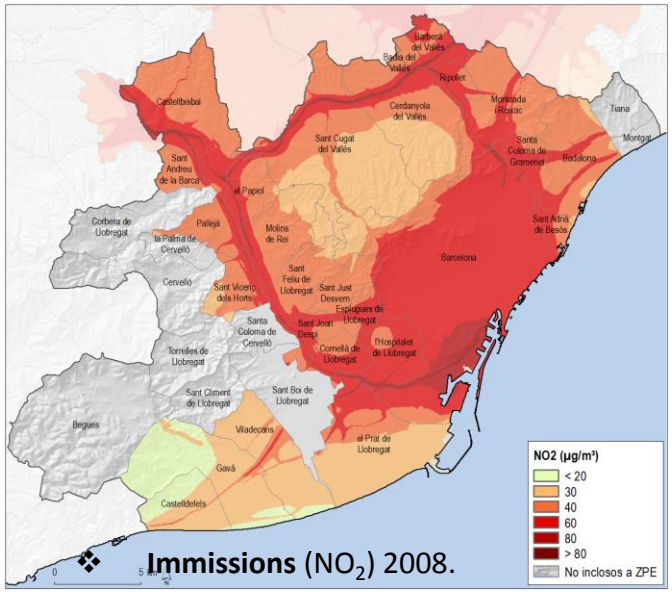
OVERVIEW

1. Background and objectives
2. Methods
3. Results
4. Conclusions
5. Ongoing research

1. BACKGROUND AND OBJECTIVES

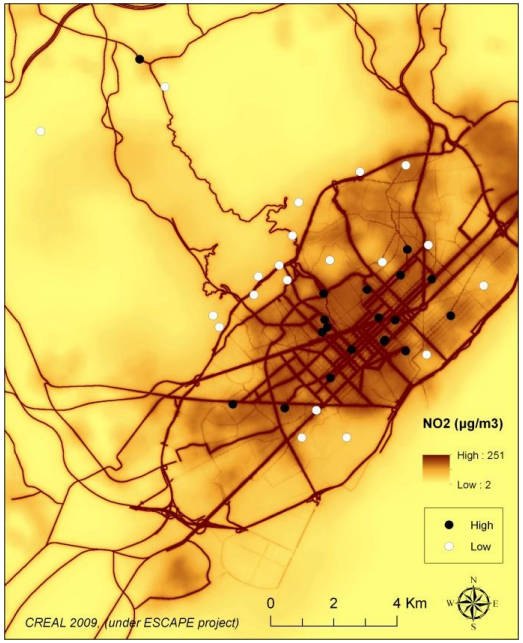
BACKGROUND: STRATEGIC ENVIRONMENTAL ASSESSMENT OF THE PMMU

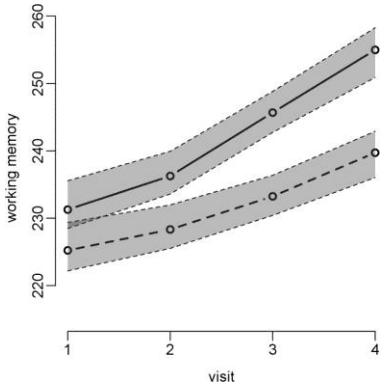
❖ **Metropolitan Area of Barcelona**



❖ **Immissions** (NO_2) 2008.

❖ **Cognitive capacity relative to schools with high or low level exposure to traffic-pollution**





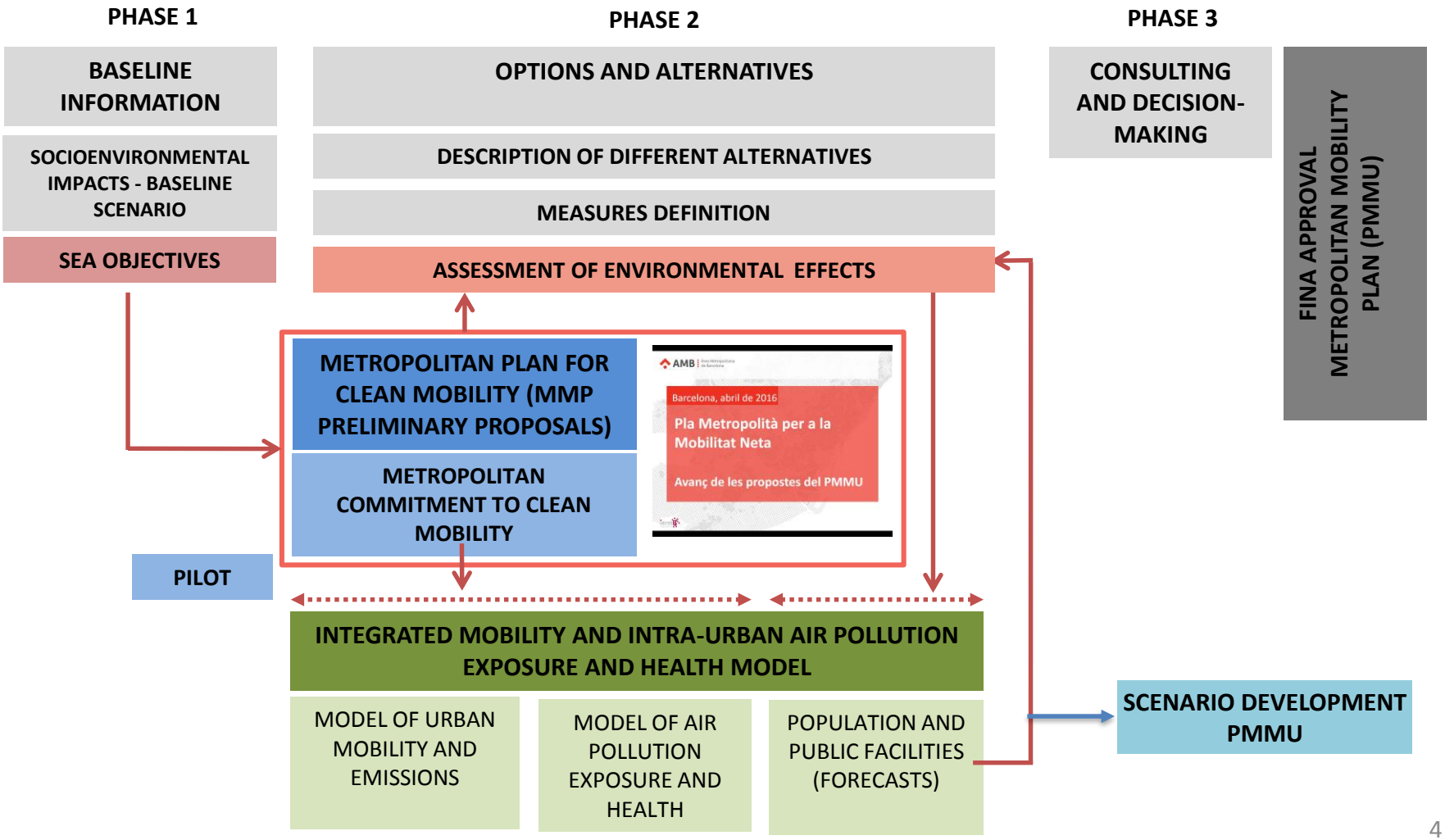
Font: Sunyer J, Esnaola M, Alvarez-Pedrerol M, Forns J, Rivas I, López-Vicente M, et al. (2015) Association between Traffic-Related Air Pollution in Schools and Cognitive Development in Primary School Children: A Prospective Cohort Study. PLoS Med 12(3): e1001792. doi:10.1371/journal.pmed.1001792

The Public Health Agency of Barcelona estimates that:

- 95% of the city's population is potentially exposed to annual levels of suspended particles higher than the WHO benchmarks, while NO2 exceeds 68% of the population.
- the reduction of PM2.5 to the annual average level proposed by WHO would annually prevent some 650 deaths in the city

1. BACKGROUND AND OBJECTIVES

BACKGROUND: STRATEGIC ENVIRONMENTAL ASSESSMENT OF THE PMMU



1. BACKGROUND AND OBJECTIVES

BACKGROUND: METROPOLITAN COMMITMENT TO CLEAN MOBILITY

Improving air quality in the Barcelona metropolitan area. Advancing proposals of the Metropolitan Mobility Plan

LOW EMISSION ZONES	1. Implementation of the Metropolitan Low Emission Zone - BMA (MLEZ) 2. Implementation of the Urban Low Emissions Zone - inside the urban ring (B-20 and B-10))(ULEZ) 3. Implementation of Low Emission Zones -city centers (LEZ)
BICYCLE	4. Construction of 400 km of bikeways in the metropolitan municipalities
BUS FLEET	5. Renewal of the bus fleet of the BMA (towards 0 diesel vehicles)
TAXI	6. 30% reduction in emissions of metropolitan taxis
PRIVATE TRANSPORT FLEET	7. Increase in the number of electric vehicles in the institutional fleets
COMMUTING	8. Incentives for sustainable mobility to and from the workplace
INFRAESTRUCTURES	9. Claim to the competent authorities for the implementation of relevant transport infrastructure and better management of the existing ones in order to improve air quality
SUSTAINABLE URBAN MOBILITY	10. Planning mobility policies in the medium term through the Metropolitan urban mobility plan (PMMU)

1. BACKGROUND AND OBJECTIVES

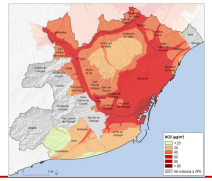
OBJECTIVES

- To develop an integrated mobility and intra-urban air pollution model of exposure and health with high spatial resolution to be used as a tool in the Strategic Environmental Assessment of the Barcelona Metropolitan Mobility Plan (PMMU)
- To assess, following an integrated approach, the pollution exposure and health impacts associated to Barcelona's mobility
- To analyze social and spatial disparities in accordance to different economic, urban and infrastructure development scenarios and the implementation of different measures of the Metropolitan Mobility Plan (PMMU)

2. METHODS

Integrated mobility and intra-urban air pollution exposure and health model

Study domain
Metropolitan Area of Barcelona



Methodology
•GIS-based development
•High spatial resolution

Period of study
Baseline scenario year 2014
Proposal PMMU scenarios years 2020 and 2025

MODEL OF URBAN MOBILITY AND EMISSIONS
(MCRIT, IC, IERMB)

MODEL OF AIR POLLUTION EXPOSURE AND HEALTH
(ISGLOBAL, IERMB)

MOBILITY MODEL
- The more complete traffic network (SIMCAT enlarged–BCN)

EMISSIONS MODEL
- Circulating vehicle fleet
- Actualized emission curves (EMEP/EEA)
- NOx, NO_2, PM_{10}, $PM_{2,5}$

AIR POLLUTION MODEL
- LUR model
- Concentration of NO_2 and $PM_{2,5}$

HEALTH EFFECTS MODEL
- Health indicators
- Dose-response curves
- Health impacts

POPULATION AND PUBLIC FACILITIES (FORECASTS)
(IERMB)

Results analysis

Baseline scenario 2014
- Pollutant emissions
- Population and public facilities exposure to mobility-based air pollutant emissions
- Population and public facilities exposure to mobility-based air pollutant concentration
- Population health effects

Proposal scenarios 2020 and 2025
- Simulation of the same indicators, proposal scenarios PMMU
- Difference between proposal scenarios and Baseline scenario
- Strategic environmental Assessment PMMU

2. METHODS

MODEL OF URBAN MOBILITY AND EMISSIONS

MODEL OF URBAN MOBILITY

TRAFFIC NETWORK AND ROAD TRAFFIC VOLUME (private and public) + O/D MATRIX

MODAL DISTRIBUTION MODEL

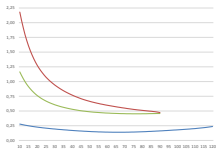
ROAD TRAFFIC ALLOCATION MODEL

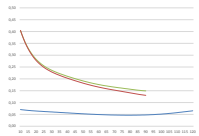
TOTAL MOBILITY (by means of transport) + FLEET OF VEHICLES (age and technology) + ROAD TYPOLOGY (speed)

MODEL OF EMISSIONS

TRANSPORT PER VEHICLE TECHNOLOGY AND ROAD TYOPOLOGY (VEH·KM/year) × **EMISSION FACTOR PER VEHICLE TECHNOLOGY AND SPEED** (g/KM x year) = **EMISSIONS PER TIPUS DE VEHICLE I TIPUS DE VIA** (g/year)

- For private transport and transport of good – mobility model
- For public transport - calculated based veh·km offer





POPULATION AND PUBLIC FACILITIES

URBAN MODEL

BASELINE SCENARIO ENVIRONMENTAL ASSESSMENT: EMISSIONS-POPULATION EXPOSURE

PROPOSAL SCENARIO ASSESSMENT (MMP) EMISSIONS-POPULATION EXPOSURE

2. METHODS

MODEL OF AIR POLLUTION AND HEALTH

MODEL OF URBAN MOBILITY

TRAFFIC NETWORK AND ROAD TRAFFIC VOLUME (private and public)

O/D MATRIX

MODAL DISTRIBUTION MODEL

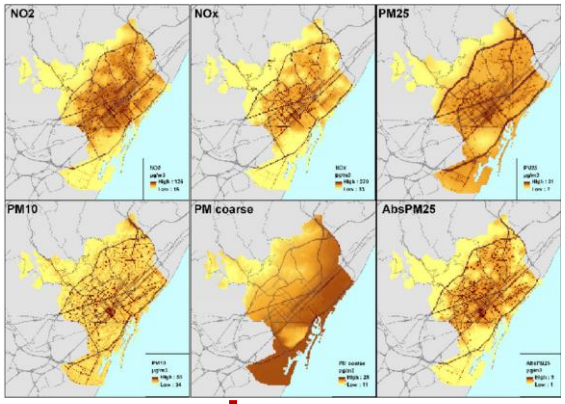
ROAD TRAFFIC ALLOCATION MODEL

TOTAL MOBILITY (by means of transport)

ROAD TRANSPORT MOBILITY (VEH·KM/ANY)

URBAN MODEL

LAND USE REGRESSION MODEL



MODEL OF AIR POLLUTION EXPOSURE AND HEALTH

POPULATION AND PUBLIC FACILITIES

BASELINE SCENARIO ENVIRONMENTAL ASSESSMENT:
NO2 AND PM2,5 CONCENTRATION-POPULATION EXPOSURE

PROPOSAL SCENARIO ASSESSMENT (MMP)-
NO2 AND PM2,5 CONCENTRATION-POPULATION EXPOSURE

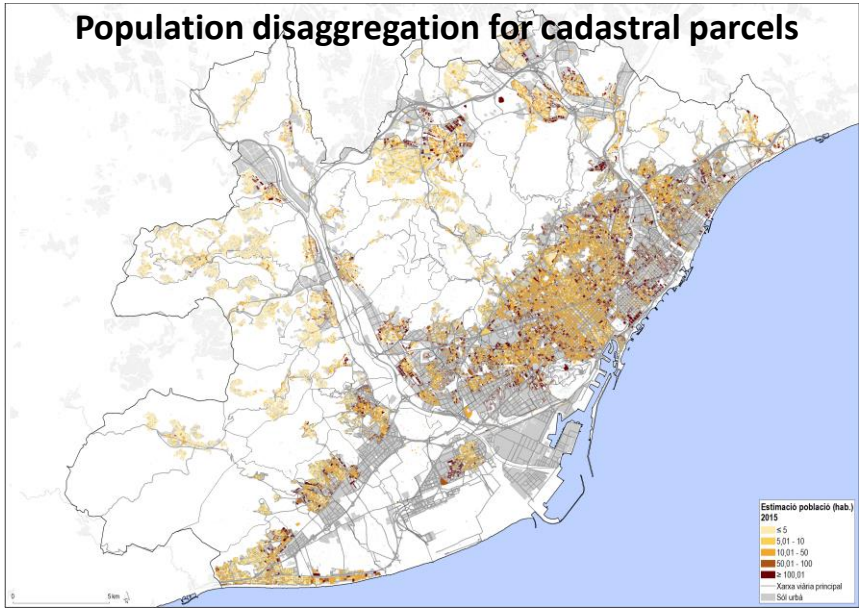
2. METHODS
POPULATION AND PUBLIC FACILITIES

- Cadastral information layer (vector and polygonal) with the associated information of the population

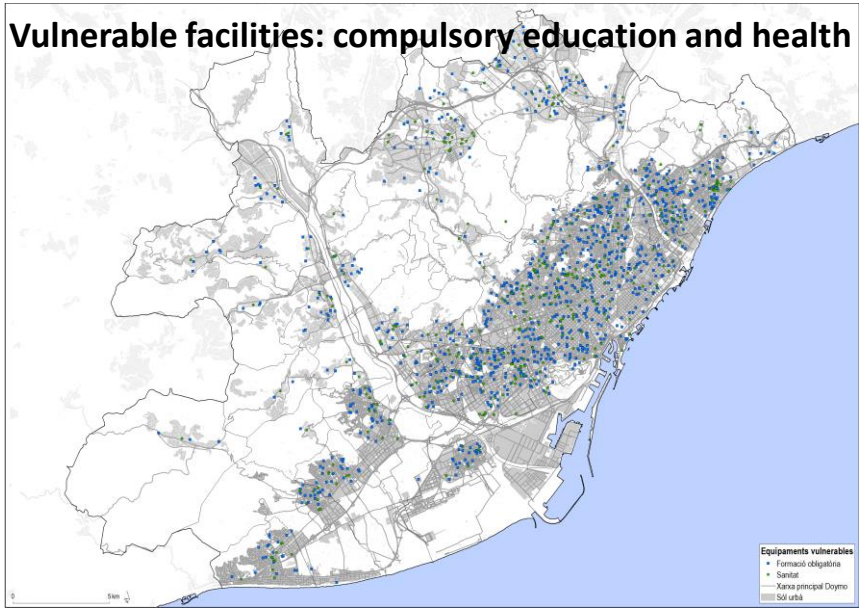
- An exhaustive graphical digitization of each public facility (2015-2016)
- The incorporation of its specific characteristics: typology, location, main user, etc.

Source: IERMB.

Population disaggregation for cadastral parcels

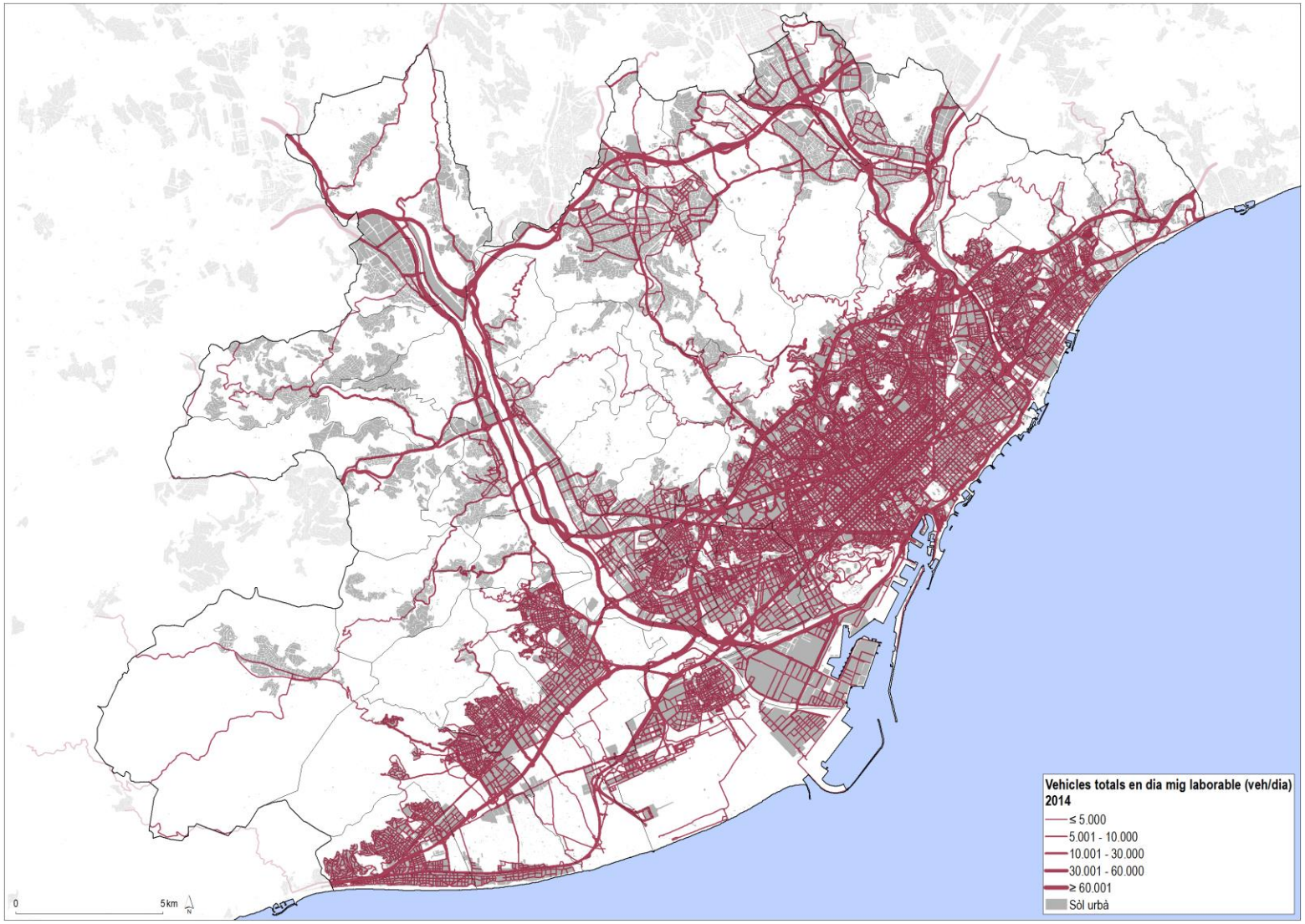


Vulnerable facilities: compulsory education and health



3. RESULTS

TRAFFIC NETWORK– BASELINE SCENARIO 2014

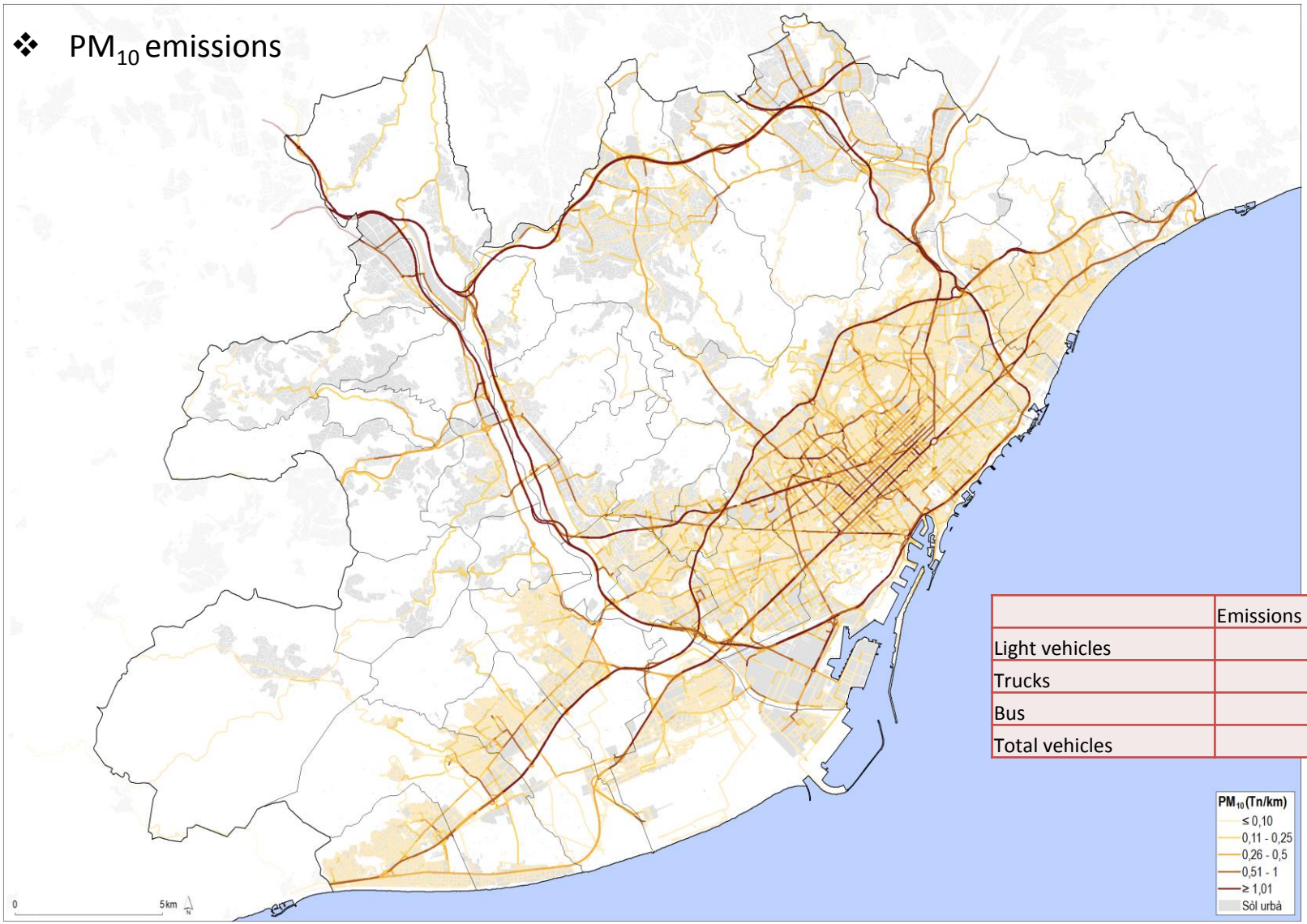


Source: IERMB.

3. RESULTS

EMISSIONS BASELINE SCENARIO 2014

- PM_{10} emissions

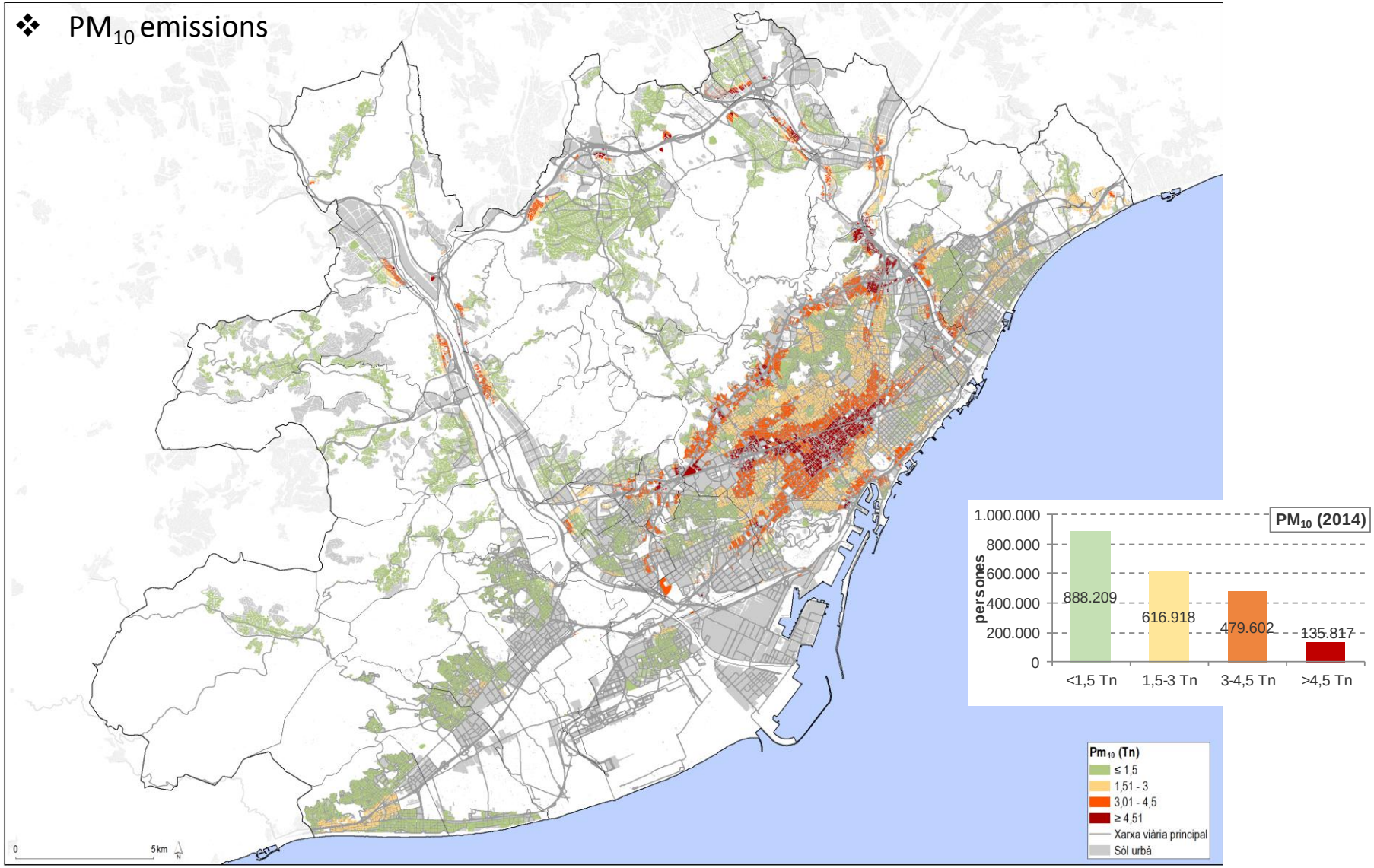


	Emissions de PM_{10} (Tn)
Light vehicles	659
Trucks	136
Bus	43
Total vehicles	838

Source: IERMB.

3. RESULTS

POPULATION EXPOSURE. BASELINE SCENARIO 2014

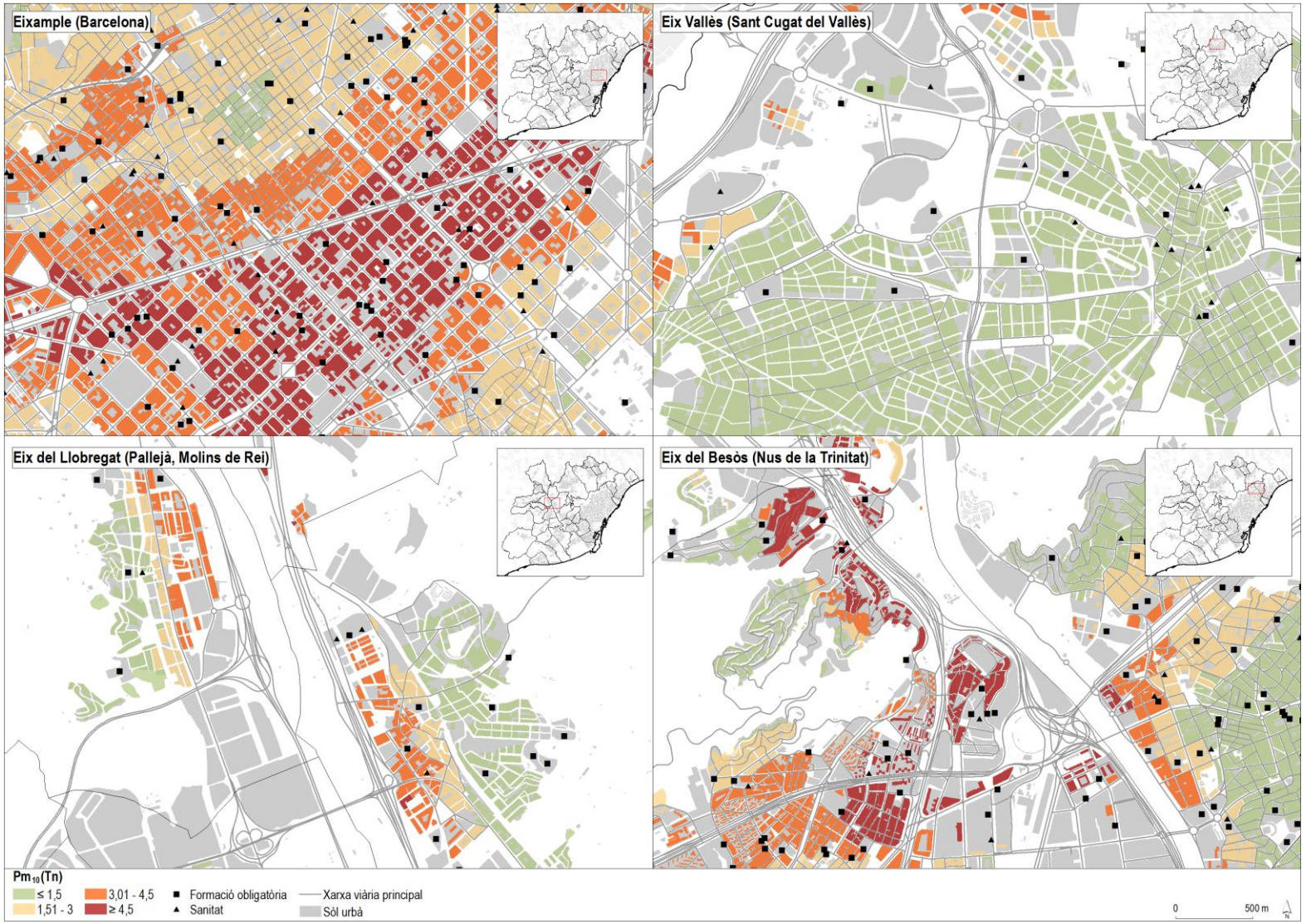


Source: IERMB.

3. RESULTS

POPULATION EXPOSURE. BASELINE SCENARIO 2014

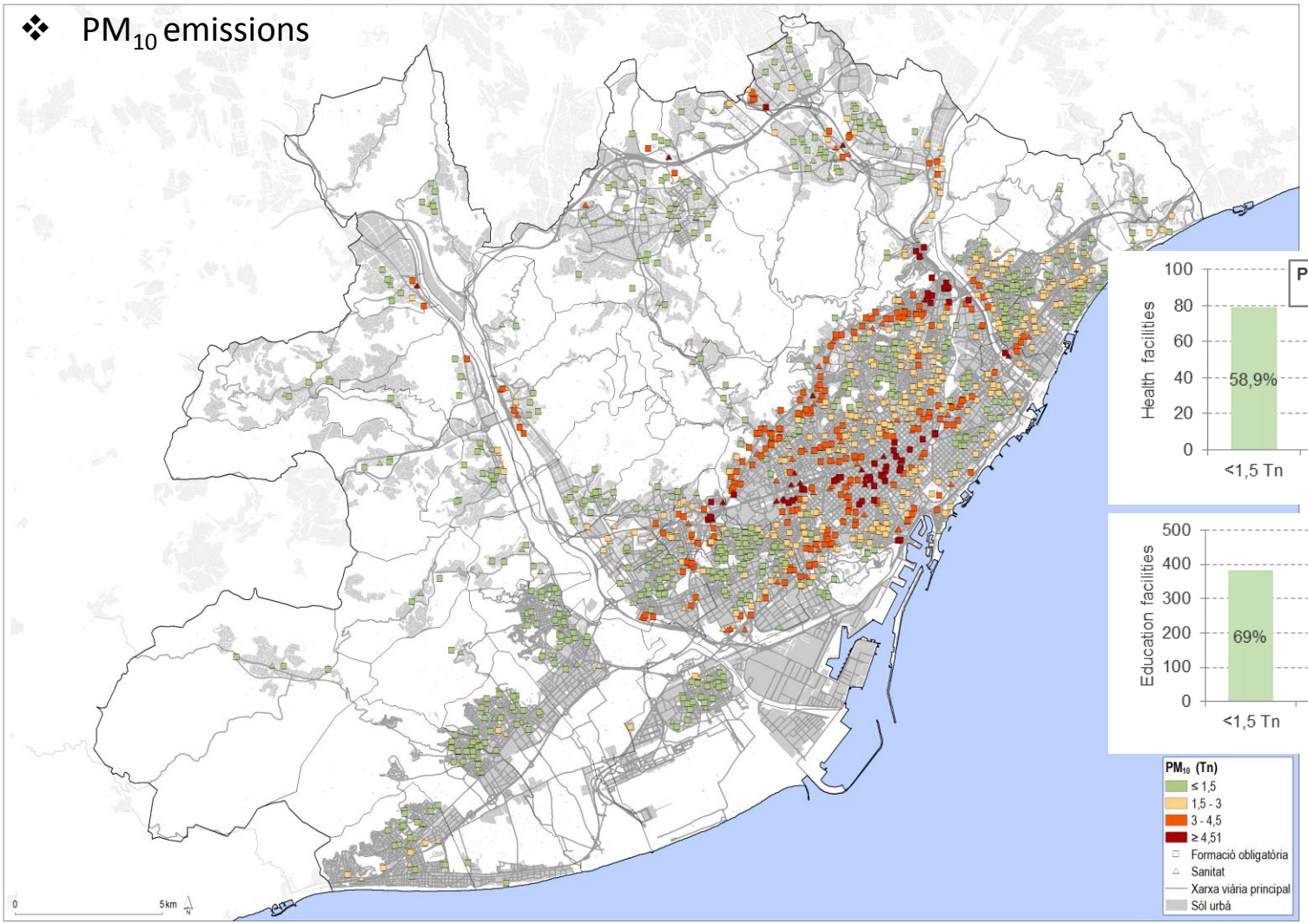
- PM_{10} emissions



Source: IERMB.

3. RESULTS

PUBLIC FACILITIES EXPOSURE. BASELINE SCENARIO



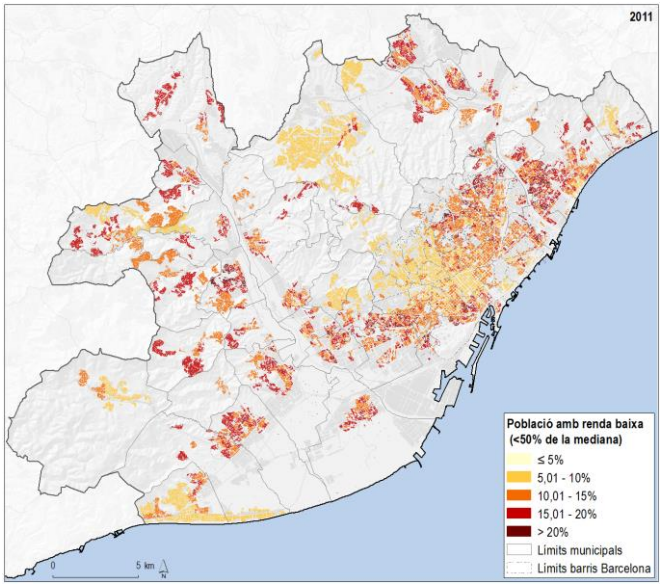
Source: IERMB.

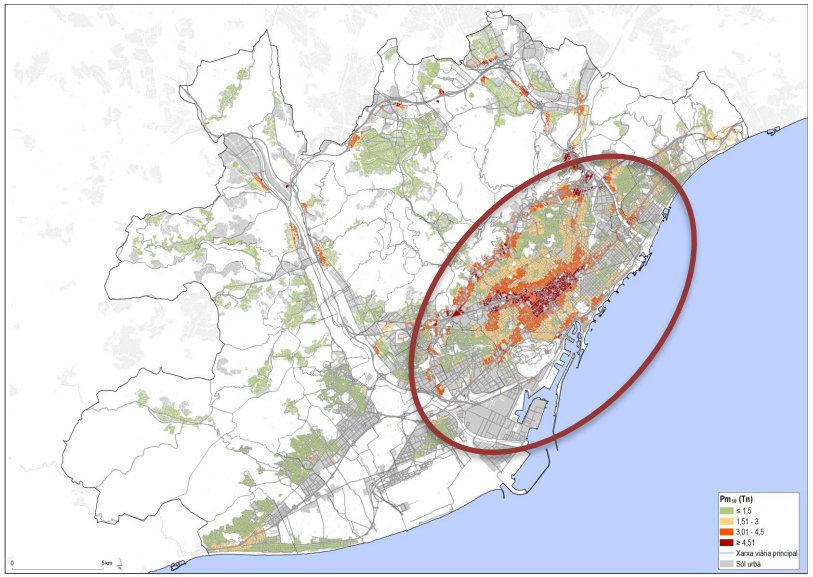
3. RESULTS
SOCIAL DISPARITIES

- Unlike many North American cities, there is no correlation between income level and pollutants' concentration (PM10)

- Urban continuum Barcelona

Income	Mean PM10 emission	Pop (%)
<10% Low income	3,14	19,00
10% - 15% Low income	2,40	50,08
15% - 20% Low income	1,87	23,60
>20% Low income	1,82	7,32





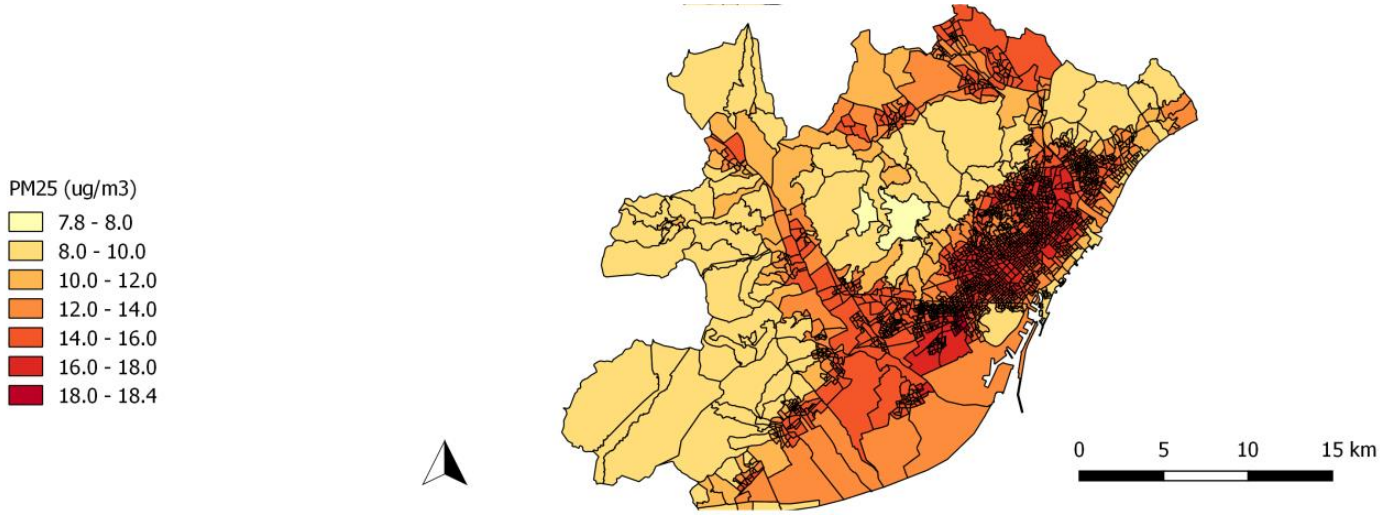
Source: IERMB.

4. CONCLUSIONS

- The model helps to identify hotspots of pollutant exposure and the socio-ecological trade-offs of different measures (infrastructure, technological, economic, traffic restrictions), to be able to define the best measures for a more sustainable and healthy mobility system.
- Future developments of the model will allow to analyse the specific effect of different traffic restriction measures in population exposure and health, and the impact in different socioeconomic groups.

5. ONGOING RESEARCH

HEALTH EFFECTS - PRELIMINARY RESULTS



Health's impact	PM2.5 - AMB	PM2.5 - Barcelona
Mortality	1.686	929
Cardiovascular disease	2.190	1.206
Brainvascular disease	828	500
Diabetes mellitus type 2	1.412	778
Premature birth	229	121
Low weight birth	519	274

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Thank you very much for your attention!

Maite.Perez@uab.cat
Elena.domene@uab.cat
Marta.garcia@uab.cat