



Nouakchott region



Convention des Maires
pour l'Afrique subsaharienne



ECONOMIC AND HEALTH IMPACT STUDY

Consequences of an improvement in air quality in the Nouakchott region

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11/04/2024



Study of air quality in the Nouakchott Region

Main aim : raise awareness of air quality issues among political decision-makers in the Nouakchott region and propose action plans, particularly in terms of monitoring.

- ❖ **Phase 1 :** Carry out an initial assessment of air quality in the city of Nouakchott in order to characterise the main parameters.
- ❖ **Phase 2 :** Deployment of a measurement campaign and updating of the data obtained in Phase 1 to take account of seasonal variations.
- ❖ **Phase 3 :** Inventory, improvement scenarios and action plan
 - ❖ methodology for calculating health and economic impact
 - ❖ ...

Health and socio-economic impact

➤ To assess the health and economic impact of air pollution in the Nouakchott region

1. quantify the impact of particulate pollution on the quality of life of the inhabitants of Nouakchott





2. realise the savings made by improving air quality

Statistical indicators




The Organisation for Economic Cooperation and Development

SANITARY

- **mortality** : number of premature deaths / year 
- **morbidity** : number of DALY / year 
Disability Adjusted Life Year is a measure of overall disease burden, expressed as the cumulative number of years lost due to ill-health, disability or early death

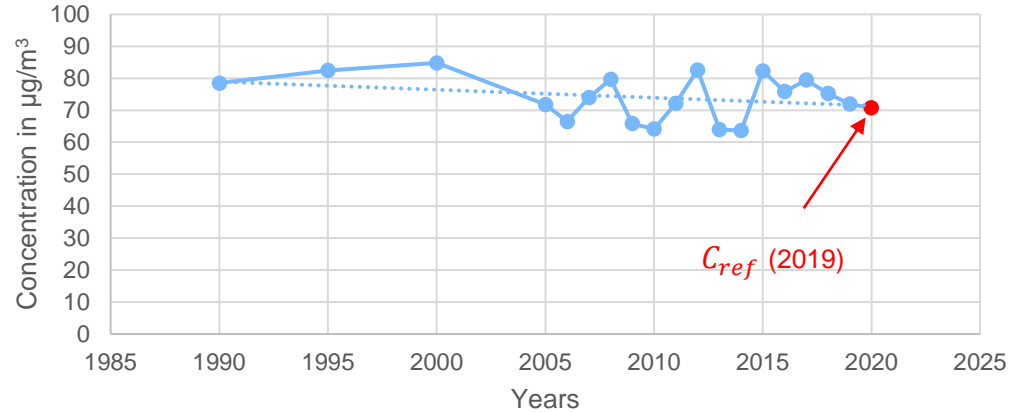
→ *Global Burden of Disease (GDB)*

ECONOMIC

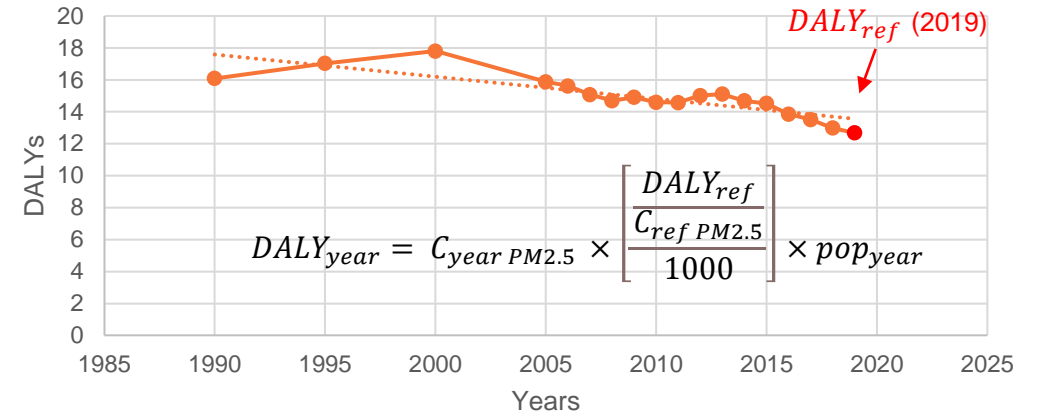
- **cost associated with mortality** : Welfare cost of death / year (relative to the VSL, the value of a statistical life, which corresponds to the value of a reduction in the risk of death) 
- **cost associated with morbidity** :
 - Welfare cost of death related to active life expectancy → Welfare cost of 1 DALY / year
 - Health expenditure / year  IHME 

Institute for Health Metrics and Evaluation

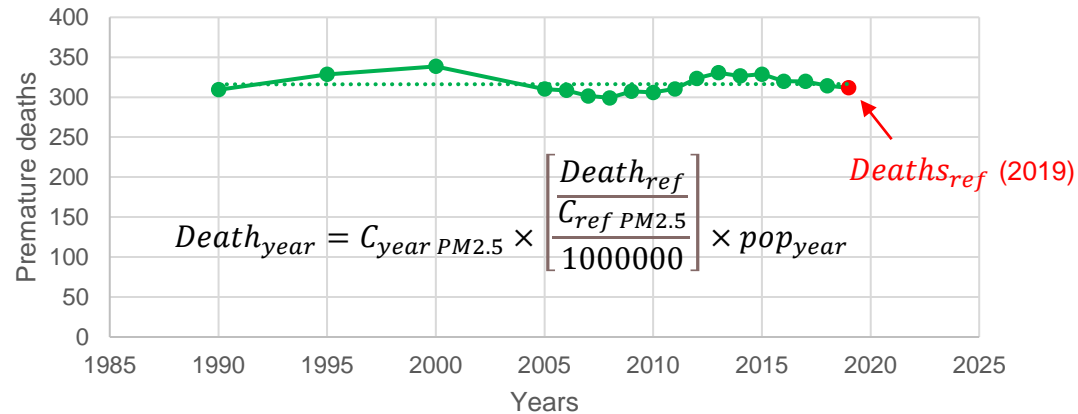
Average population exposure to PM2.5



DALYs, per thousand inhabitants



Premature deaths, per million inhabitants



Based on PM2.5 concentrations for each municipality in the city of Nouakchott :

- Calculation of the number of DALYs
- Calculation of the number of premature deaths

Reference : <https://stats.oecd.org/index.aspx>

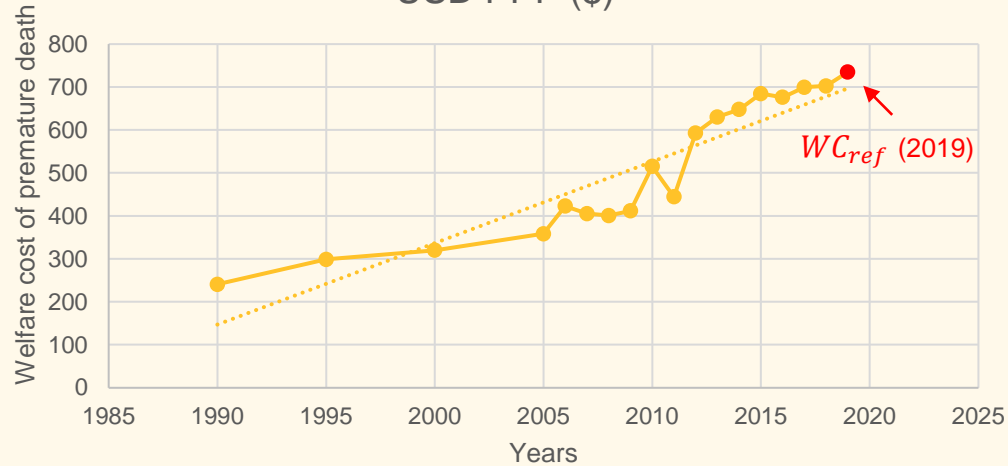
Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet.

Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019

Methodology for the economic study | Mauritania data

Mortality

Welfare cost of premature deaths, in millions 2015 USD PPP (\$)



→ Estimated welfare cost of a premature death (in million USD 2015 PPP) :

$$WC_{year} = Death_{year} \frac{WC_{ref}}{Death_{ref}} \quad \text{---} \quad VSL_{ref}(2019)$$

VSL : value of a statistical life

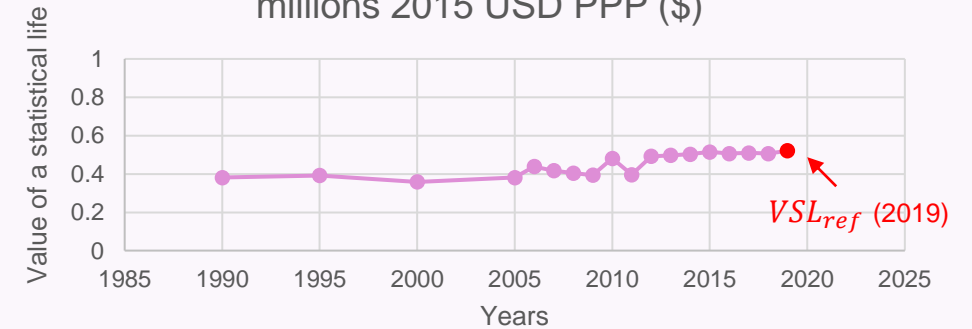
$$\rightarrow VSL/year \approx \frac{VSL}{Esp}$$

Esp : life expectancy working life (~45 years)



Morbidity

Value of a statistical life in Mauritania, in millions 2015 USD PPP (\$)



→ Estimated welfare cost of a DALY per inhabitant associated with an active life (=45 years) in million USD 2015 PPP :

$$CD = \frac{VSL_{ref}(USD\ 2015\ PPP)}{Esp(active)} \times DALYs$$

→ Estimated health expenditure linked to air pollution in 2019 :
~10% of the annual health budget

→ 21,2 USD 2021 PPP / inhabitant (normalised)

+ population 2019 : ~ 4 284 000

+ DALYS 2019 : ~ 57500

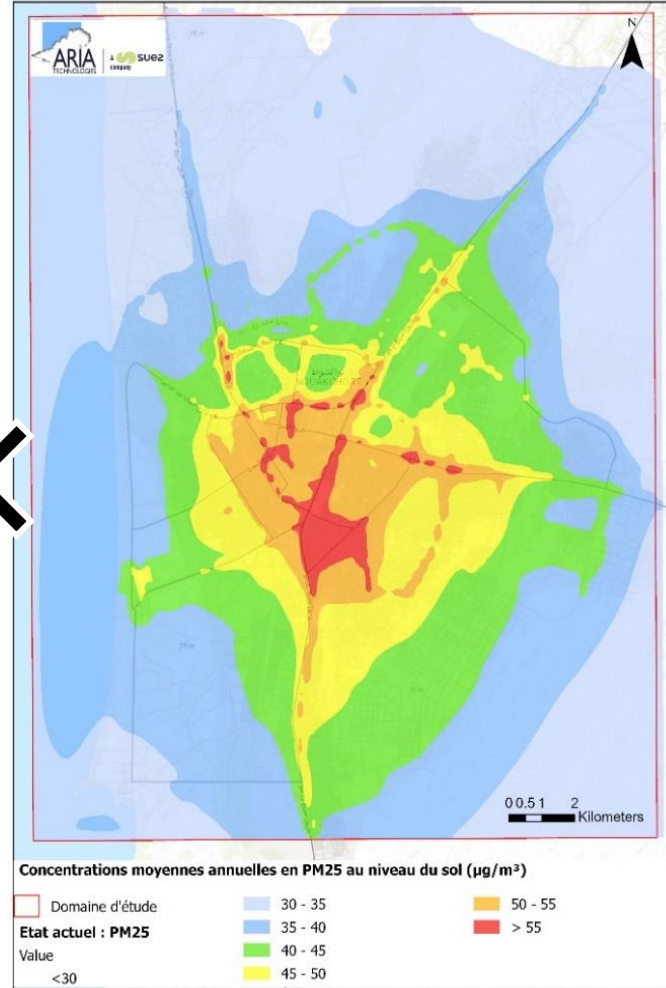
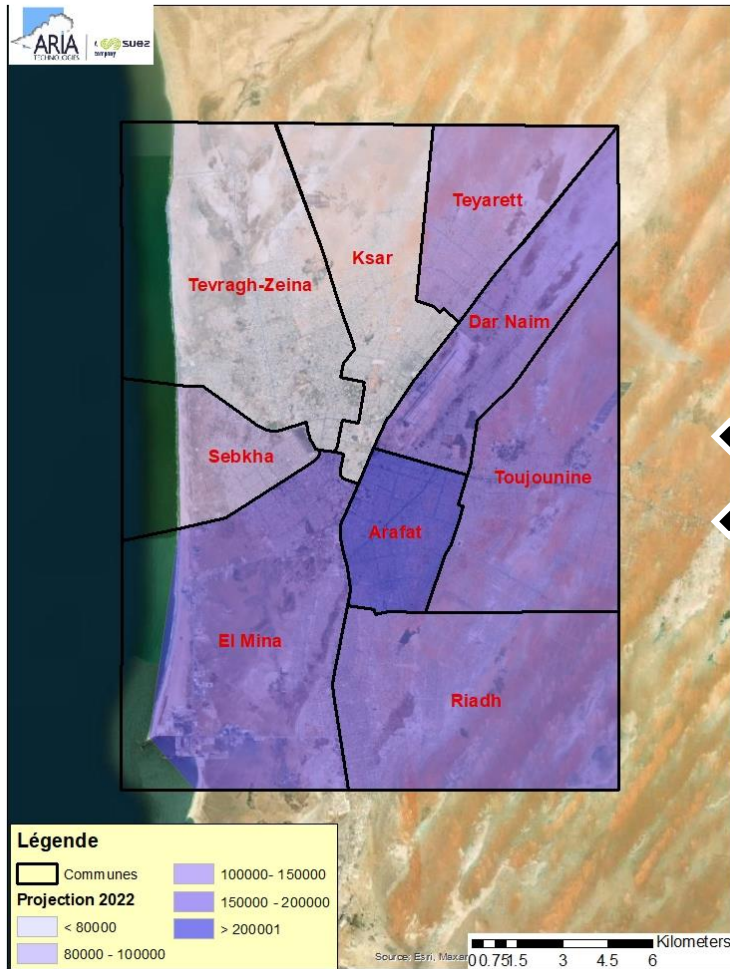
→ 1 DALYs : 1600 USD 2021 PPP



$$CS = 1600 \times DALYs / 1000000$$

PM 2.5 concentrations, 2023 estimate

➤ Health and economic impact methodology is based on a correlation between the number of inhabitants and their PM exposure



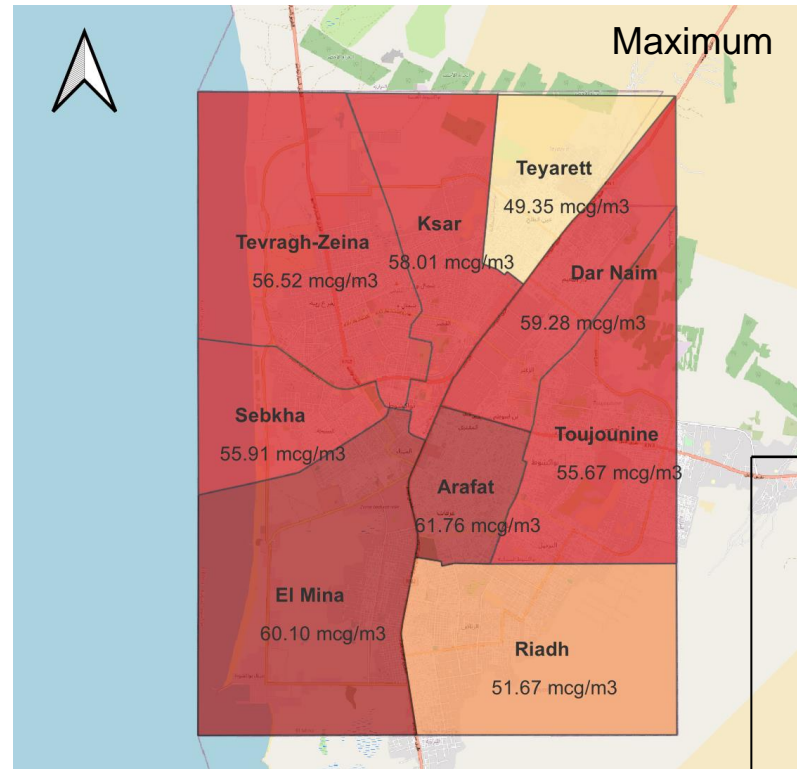
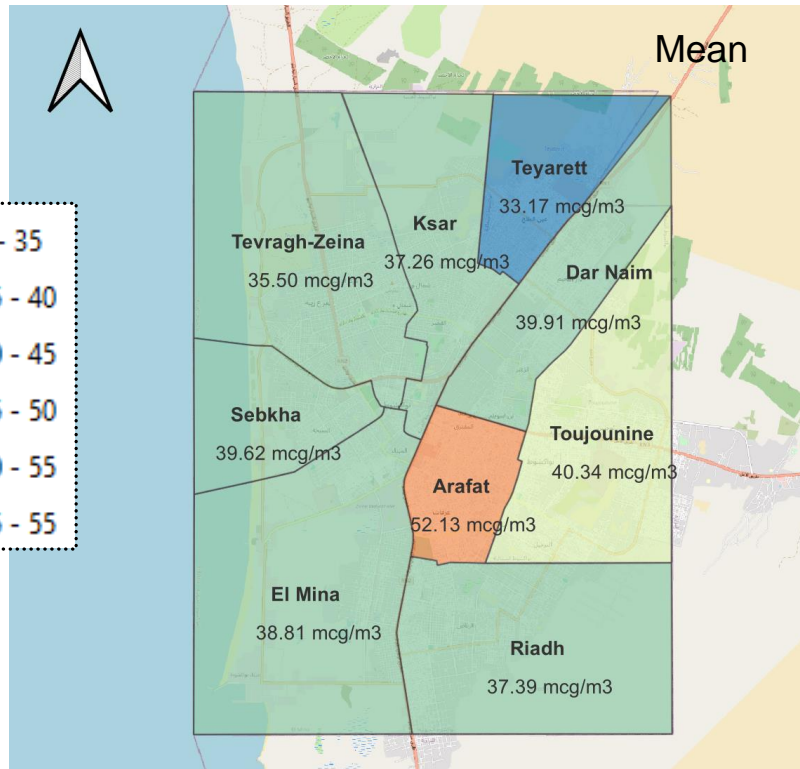
➤ **Population assumption** : data by municipality

➤ **Exposure assumption**: each Mauritanian is exposed to PM2.5 concentrations between

- the mean
- and the maximum estimated in his region

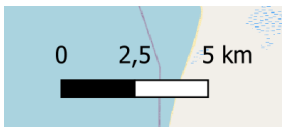
→ assumption allowing to consider the mobility of a Mauritanian from one region to another

PM 2.5 concentrations, 2023 estimate

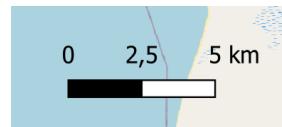


	WHO recommendations
PM _{2,5}	Annual average: 5 µg/m ³ . Daily average: 15 µg/m ³ (max 3 days/year)

Rang	Ville	Pays	PM2,5
1	N'Djamena	Tchad	89,7
2	New Delhi	Inde	89,1
3	Bagdad	Irak	86,7
4	Manama	Bahreïn	66,6
5	Dhaka	Bangladesh	65,8
6	Ougadougou	Burkina Faso	63
7	Koweït City	Koweït	57,5
8	Abu Dhabi	Émirats arabes unis	48
9	Douchanbé	Tadjikistan	47,7
10	Le Caire	Égypte	47,4
11	Abuja	Nigeria	46,5
12	Riyad	Arabie saoudite	46,2
13	Khartoum	Soudan	44,6
14	Kigali	Rwanda	44
15	Doha	Qatar	41,8
16	Kathmandu	Nepal	40,7
17	Islamabad	Pakistan	40,6
18	Hanoi	Vietnam	40,1
19	Kampala	Ouganda	39,6
20	Jakarta	Indonésie	36,2



Overall value weighted by population: 40.57 µg/m³



Overall value weighted by population: 56.91 µg/m³

Source: Rapport mondial sur la qualité de l'air

https://www.ouest-france.fr/leditiondusoir/2023-03-20/pollution_capitales



Overall results on Nouakchott's health and economy

Annual exposure based on average PM2.5 concentrations

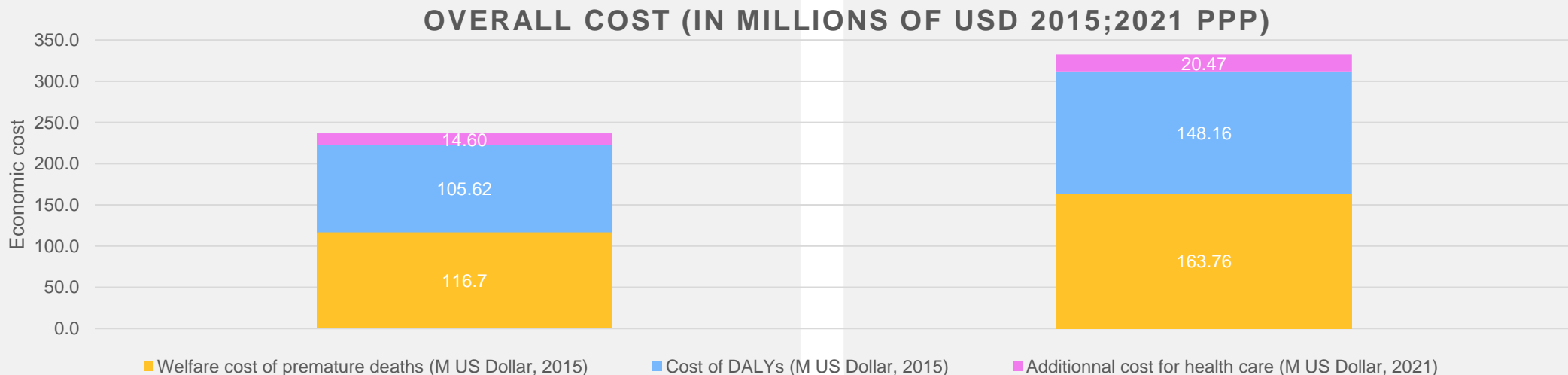
Population-weighted average concentration: 40.57 $\mu\text{g}/\text{m}^3$

- Total number of DALYs: 9120 ~ 7 people out of 1 000
- Total number of premature deaths: 225 ~ 1.8 out of 10,000 people

Annual exposure based on maximum PM2.5 concentrations

Population-weighted average concentration: 56.91 $\mu\text{g}/\text{m}^3$

- Total number of DALYs: 12 800 ~ 10 people out of 1 000
- Total number of premature deaths: 315 ~ 2.5 out of 10,000 people

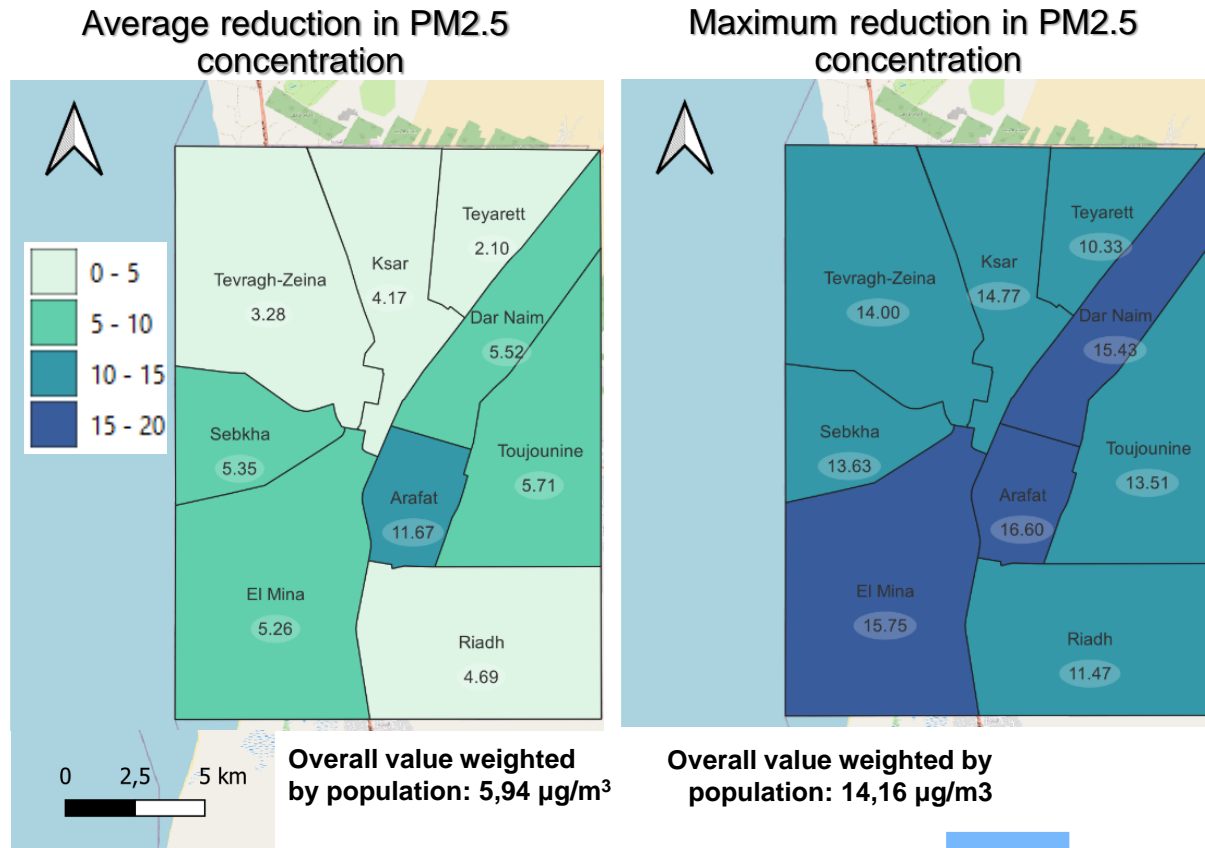


- US\$ 220 million 2015 PPP + US\$ 15 million 2021 PPP

- US\$ 310 million 2015 PPP + US\$ 20 million 2021 PPP

Improvement in PM2.5 air quality : emissions reduction strategy

Reduction strategy	Improving the mechanism for open burning of waste	Paving roads to limit the resuspension of PM	Implementation of a Bus Rapid Transit system
Estimated percentage reduction	Reduction de 80%	Reduction de 50%	Réduction de 20%



Results:

→ decrease in the weighted average:

- mean values: 40,57 → 34,64 µg/m³
- maximum values: 56,91 → 42,75 µg/m³

→ above WHO recommendations:

	Recommandations OMS
PM _{2,5}	En moyenne annuelle : 5 µg/m³ En moyenne journalière : 15 µg/m³ (max 3 j/an)

→ concentrations reduced by up to 39% in the capital

→ fall in the ranking of the most polluted capitals 8-18 to 14-20+

Impact of emission reductions on health and economy - 2023

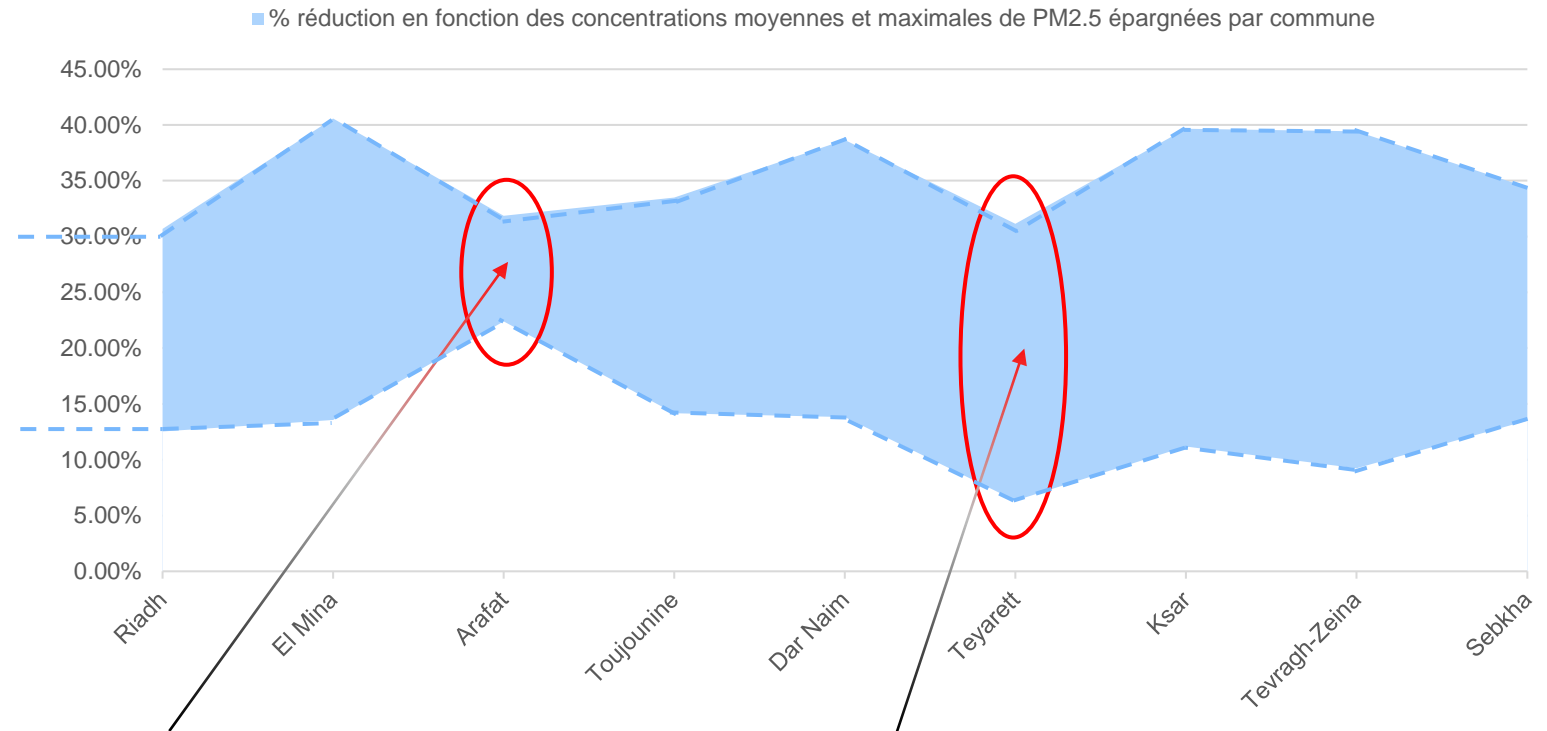
Assumption of linearity between concentrations and impact of:

- morbidity
- mortality
- economic

$$\frac{\text{Maximum concentrations spared with reduction strategy}}{\text{Mean concentrations calculated without reduction strategy}}$$

$$\frac{\text{Mean concentrations spared with reduction strategy}}{\text{Mean concentrations calculated without reduction strategy}}$$

Percentage reduction in economic and health impact by Nouakchott municipality



Arafat: municipality containing the majority of the highest PM2.5 concentrations
 → small difference between average and maximum concentrations in the commune.

Teyarett: municipality least impacted by emissions (even before reduction)
 → concentrations reduced in proportion to the impact of sources

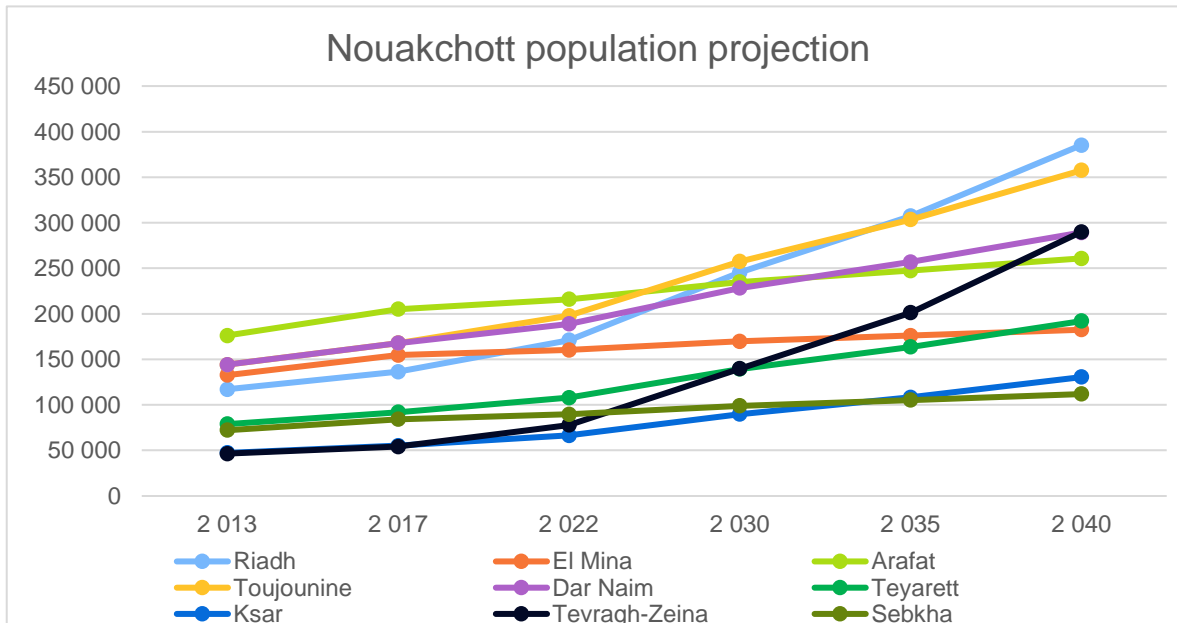
→ on average: 15-35% reduction

Projection to 2030

➤ Taking into account the time required to deploy emission reduction measures

Population update to 2030:

- Highest growth : Tevragh-Zeina, Riadh
- Near-stationary growth: Sebkhha, Arafat, El-Mina
- Total: + 325,000 inhabitants



Source : Plan de Mobilité Urbaine Durable (PMUD) 2022 et Schéma d'aménagement et d'urbanisme (SDAU) 2018 Elaboration du Plan de Mobilité Urbaine Durable (PMUD), Région de Nouakchott – ARENDDRE, Octobre 2022

Average reduction of 15 to 35% applied to population change in 2030:

DALYs

from - 1700 to - 3970 out of 11300
 → from 4.6 to 6 people out of 1,000 each year instead of 7

Premature deaths

from - 40 to - 100 out of 280
 → from 1.1 to 1.5 people out of 10,000 inhabitants each year instead of 1.8

Economic cost

from -40 to -100 out of 295 million USD PPP
 → from 190 to 250 million USD PPP instead of 295 each year

Conclusions

Methodology :

- Calculation of morbidity (DALYs), mortality (premature deaths) and associated economic calculations
- Based on OECD and IHME data

Projected concentrations by municipality in 2023 :

- Nouakchott is estimated to be ranked between 8th and 18th in the world among the most polluted capitals
- Municipality of Arafat is the most exposed to pollution and Teyarett is the least exposed to pollution

Health and economic results 2023 (based on average PM2.5 exposure per municipality) :

- 7 out of 1,000 Mauritians are likely to lose one year of good health per year
- 1.8 out of 10,000 Mauritians are likely die prematurely
- economic cost of around USD 230 million PPP

Emissions reduction results by 2030:

- 15 to 35% reduction in the impact of morbidity, mortality and economic costs
- + 325,000 more inhabitants in Nouakchott, with Arafat showing virtually flat growth

~ savings of around 1700 to 4000 DALYs out of 11300 /year

~ savings of around 40 to 100 premature deaths out of 280 /year

~ monetary savings of USD 42 to 102 million PPP out of 295 /year

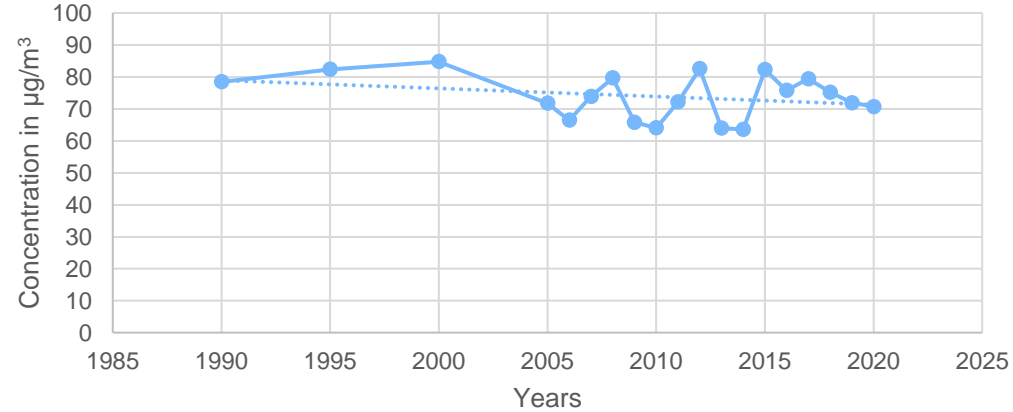
APPENDICES

Modélisation et fourniture de données météorologiques et océanographiques qualifiées

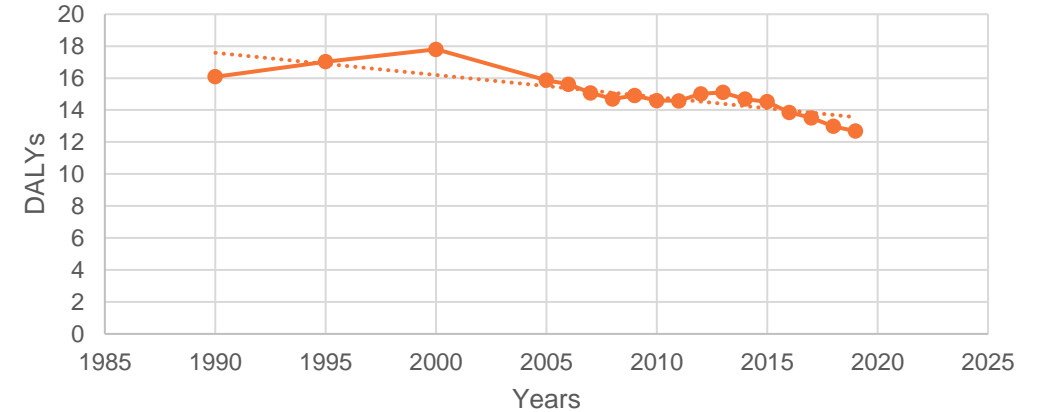


Data - Ambient particle pollution in Mauritania

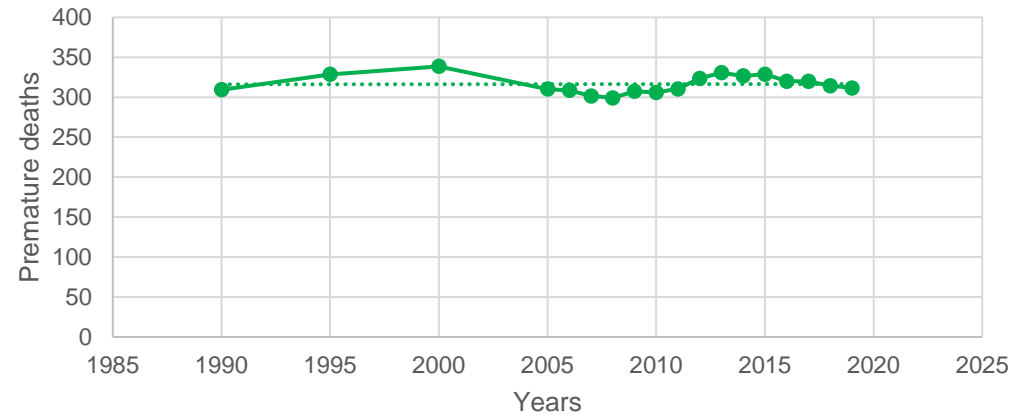
Average population exposure to PM2.5



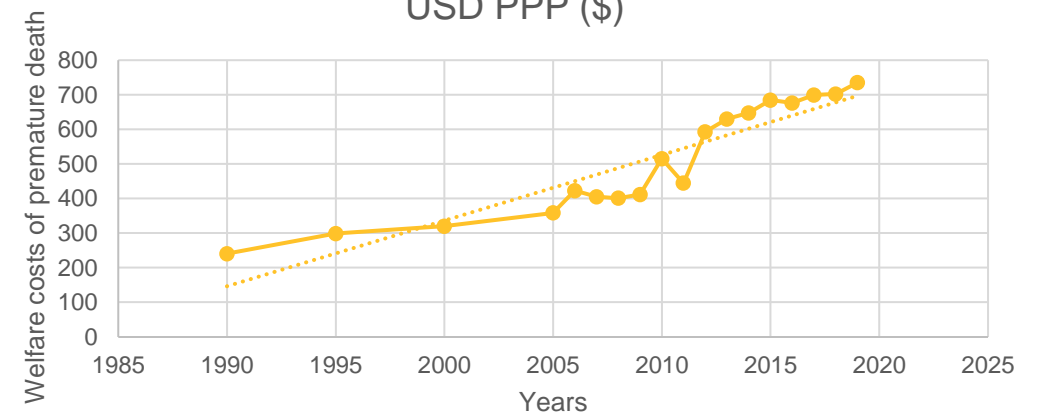
DALYs, per thousand inhabitants



Premature deaths, per million inhabitants



Welfare cost of premature deaths, in millions 2015 USD PPP (\$)

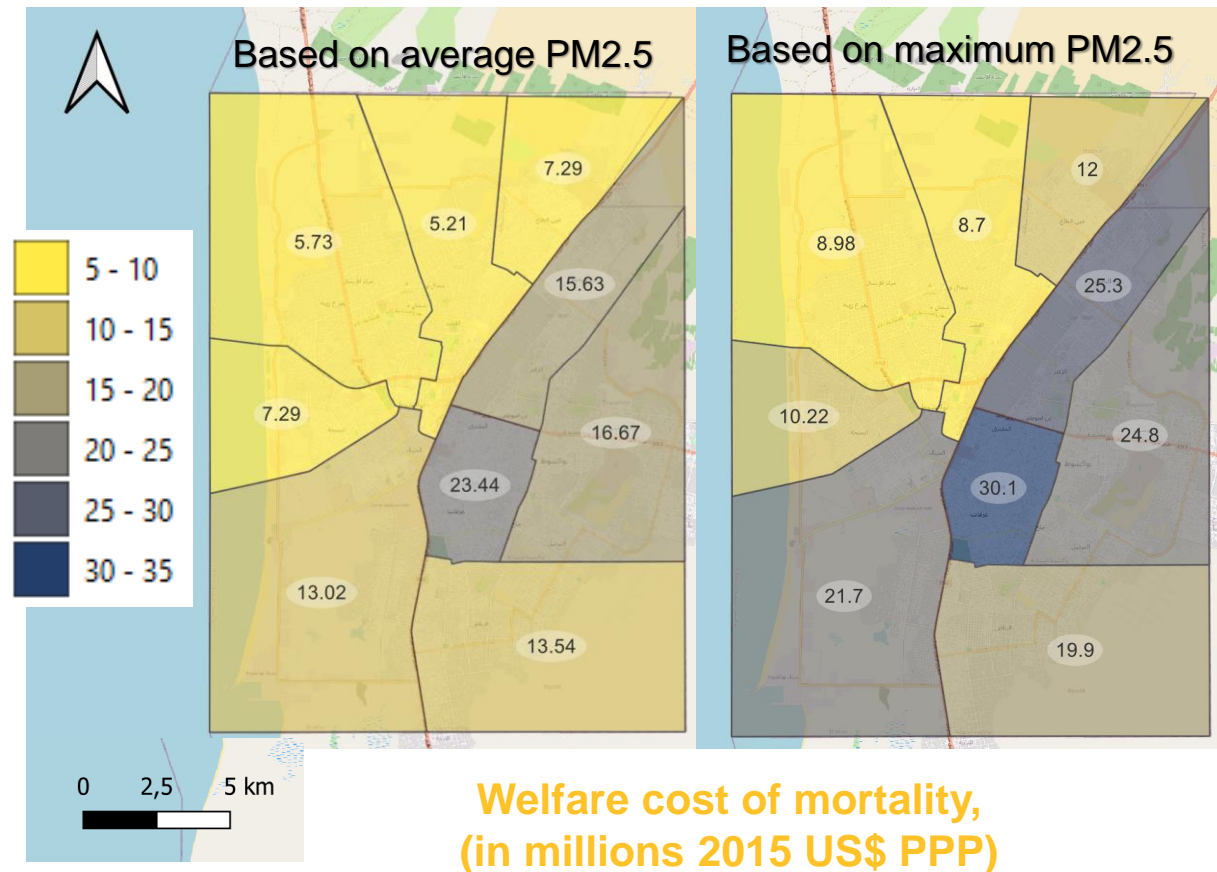
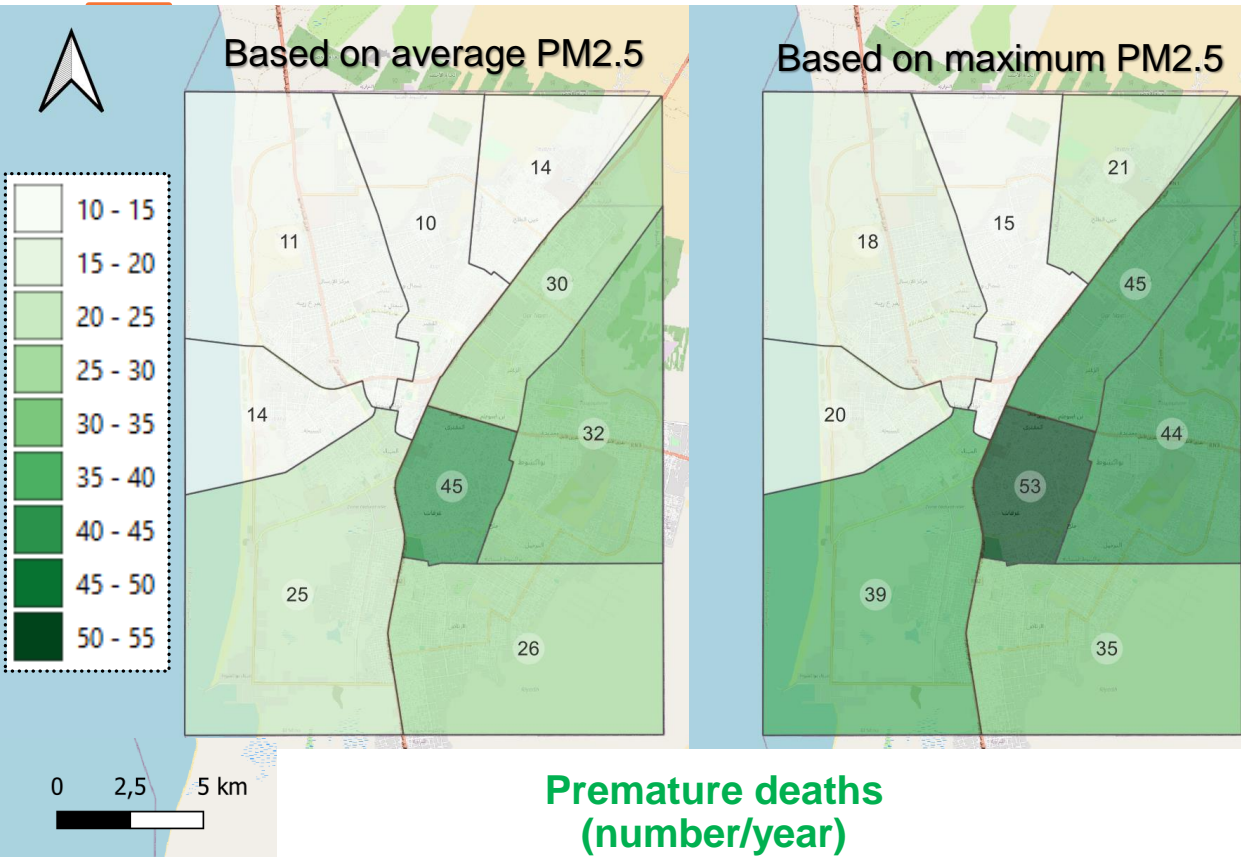


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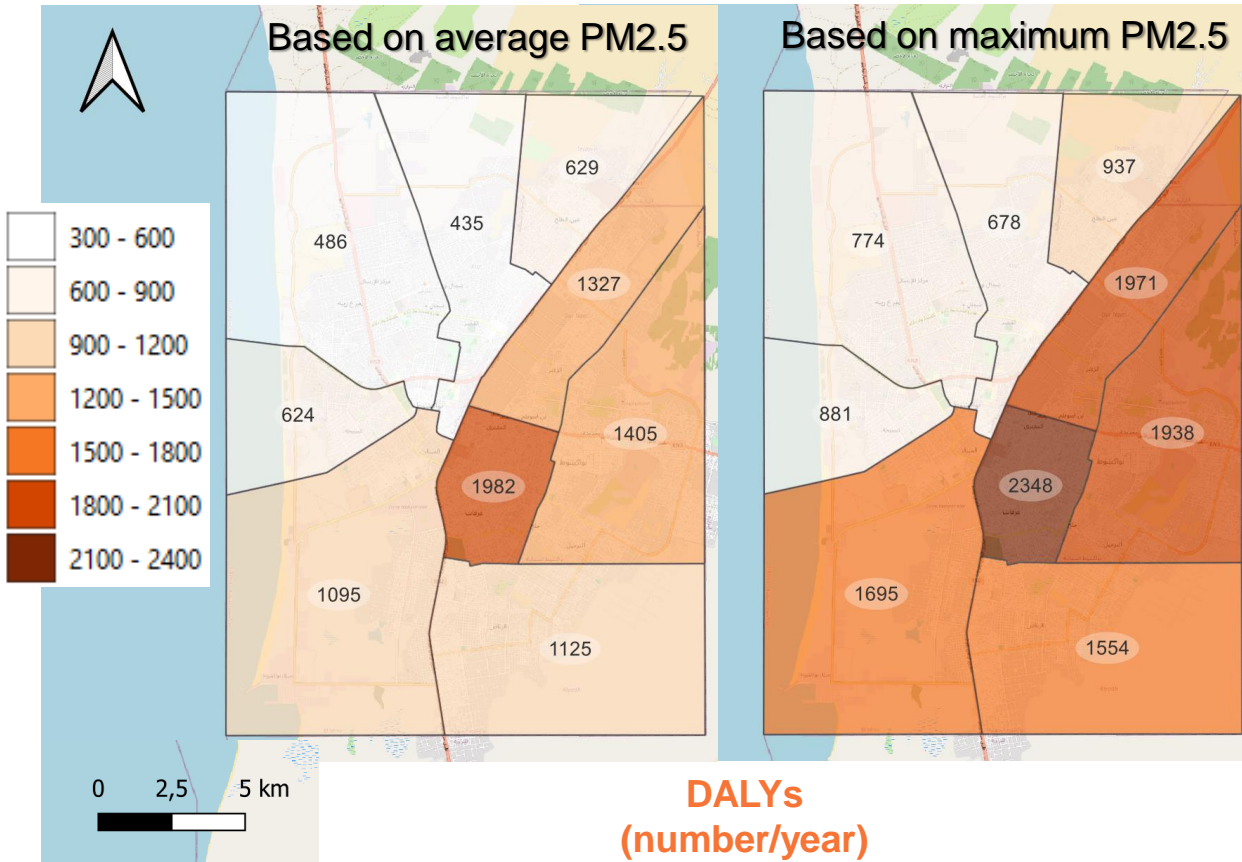
Estimated mortality and cost of mortality in 2023



Main spatial results for 2023 :

- 3 municipalities communes most affected: Arafat, Toujounine, Dar Naim
- Max premature deaths are observed in the municipality of Arafat; linked to population density

Estimated morbidity and cost of morbidity in 2023



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