Gabès Through the Lens of Simulation

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Academic Year: 2025 / 2026

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Abstract

This mini-project evaluates how industrial pollution in Gabès–Ghannouch affects human life expectancy. Using national health statistics and WHO risk factors, a simulation estimates the years of life lost due to rising PM2.5 exposure. The results highlight a clear and worrying decline in lifespan, reflecting the daily burden carried by residents living in a damaged environment. The study calls for urgent environmental action to protect both the people and the natural ecosystem of Gabès.

1.Define the problem

Gabès and Ghannouch, once a thriving Mediterranean paradise now bear the heavy cost of industrialization.

Since 1972, chemical pollution and PM2.5 emissions have degraded the environment, threatening both human life and marine ecosystems.

Objective:

To show how pollution in Gabès (Ghannouch) steals years of life from humans and destroys the sea that once thrived

2.Problem formulation

a 100% healty person living in ghannouch exposed to PM2.5

BUT FIRST ...WHAT IS PM2.5:

PM2.5 are tiny airborne particles (≤2.5 µm) from industrial emissions, traffic, and waste burning. They penetrate deep into the lungs and bloodstream, increasing risks of respiratory and heart diseases, cancer, and premature death. In Gabès and Ghannouch, high PM2.5 levels from industrial activity pose a serious threat to public health.

key variables :

LE_ref : baseline life expectancy (~77 years)

age0 : current age of the individual

PM2.5 increase : ΔPM in µg/m³

RR_per10 : relative risk per 10 µg/m³ PM2.5

LE_new : estimated life expectancy under pollution exposure

Research Questions

1.How much does PM2.5 pollution reduce life expectancy?

2.What is the loss of years for different pollution scenarios?

3.How does life expectancy change conditionally with age?

Modeling Method

Approach: Simple simulation based on scientific data

Formula:

LE’=(LE (ref))/RR

Scenarios:

ΔPM = 0, 5, 15, 30 µg/m³

Implementation:

Python code calculates life expectancy and visualizes results.

3.data collection

Provide all inputs needed for the Python simulation to estimate life expectancy under pollution.

Data Type	Source / Input Used
Life expectancy (LE_ref)	Tunisia statistics, World Bank 2023 → 77 years
Current age (age0)	Assumed for simulation → 30 years
Air pollution (ΔPM)	Studies & reports for Gabès/Ghannouch → 0, 5, 15, 30 µg/m³ scenarios
Health risk (RR_per10)	WHO / Global Burden of Disease → +8% per 10 µg/m³ PM2.5

STEP 4: MODEL CREATION, DEVELOPMENT AND FORMULATION

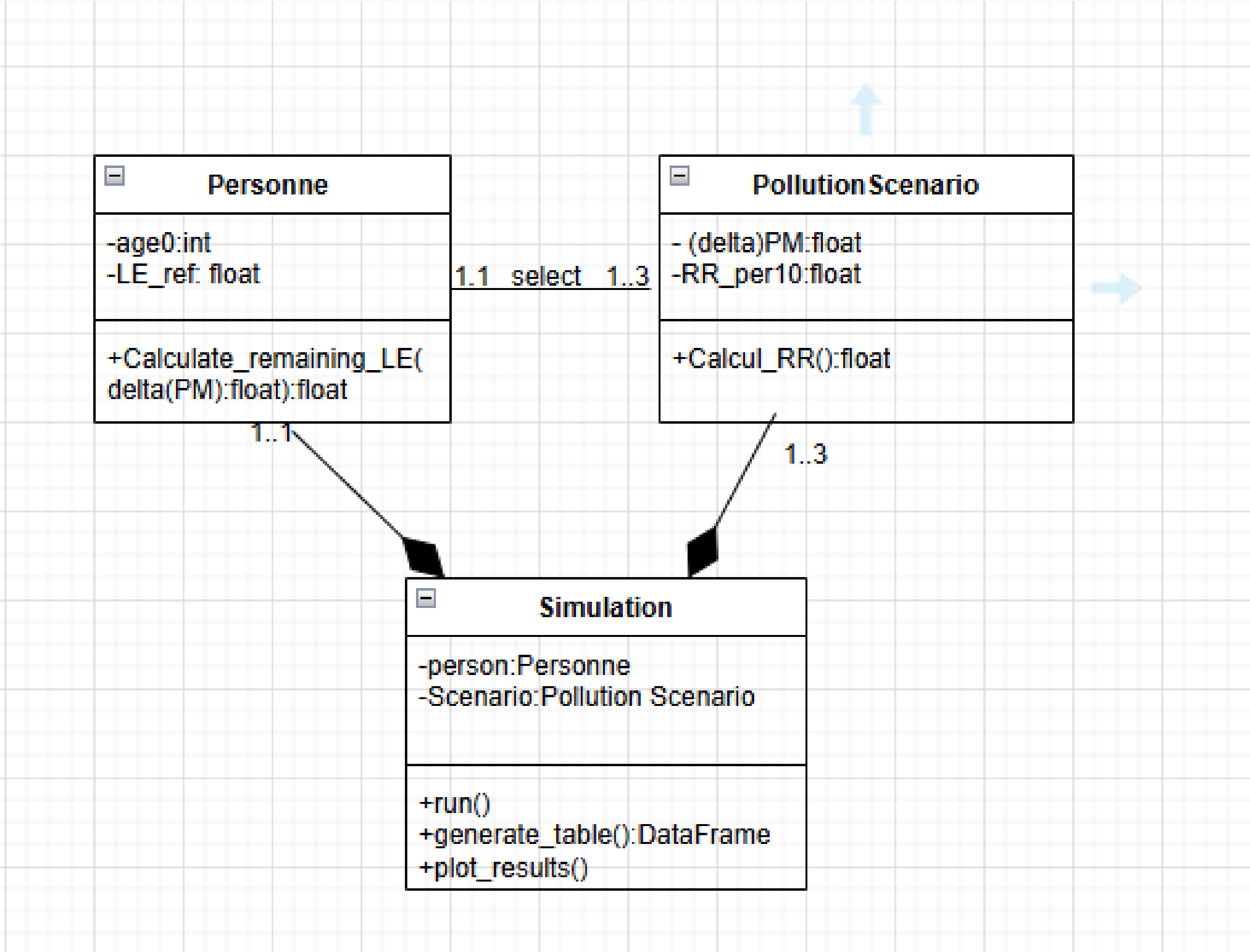
Model Type

Deterministic: outputs fully determined by inputs, no randomness.

Continuous: uses continuous variables (age, pollution level, risk).

Age-dependent / quasi-dynamic: calculates remaining life expectancy at different ages for various pollution scenarios.

Conceptual Model

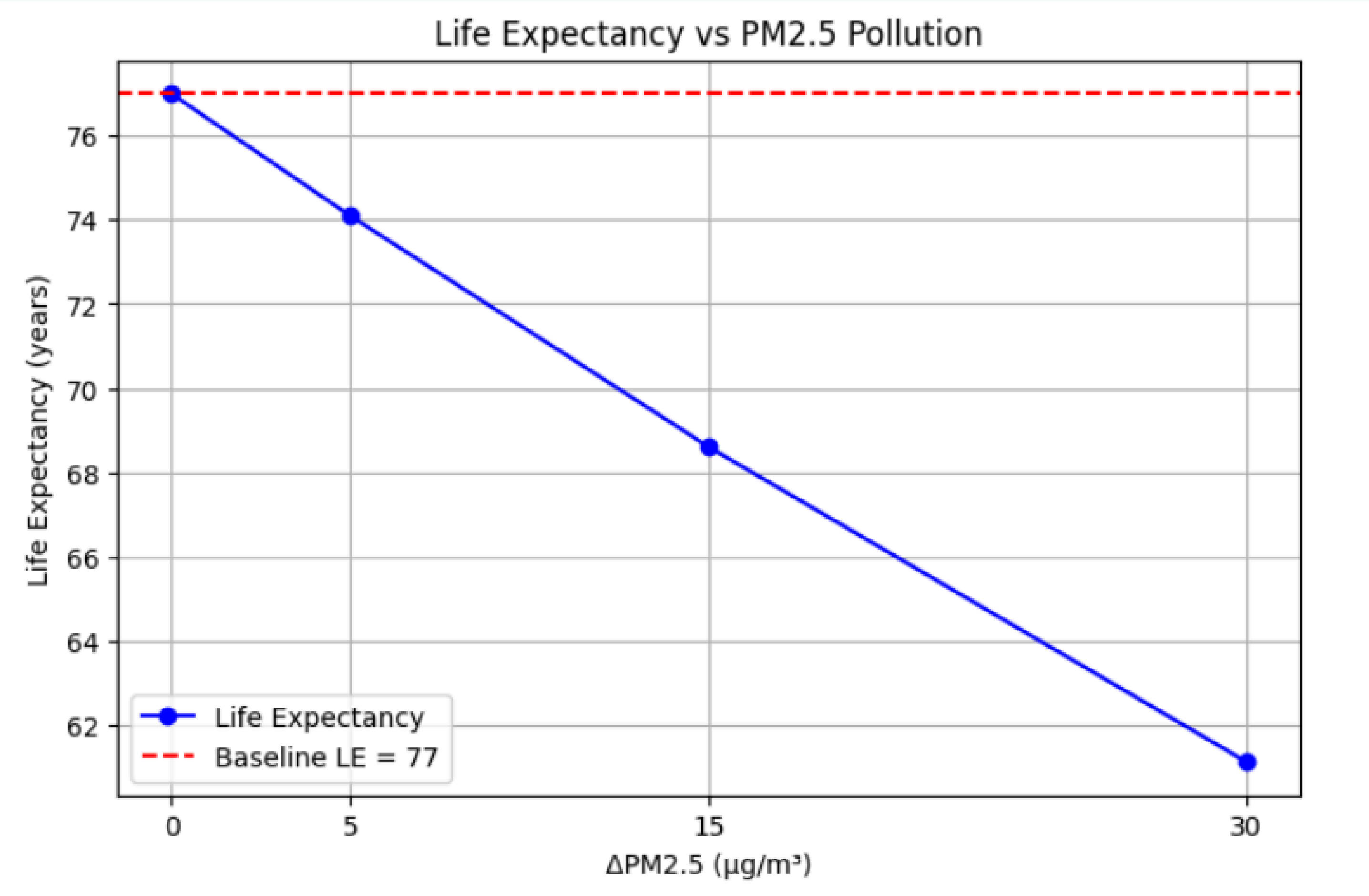


VALIDATION & ACCURACY

the ouput

	ΔPM2.5 (µg/m3)	Espérance de vie (ans)	Perte estimée (ans)
0	0	77.00	0.00
1	5	74.09	2.91
2	15	68.60	8.40
3	30	61.13	15.87

Tableau sauvegardé : espérance_vie_PM25.csv



INTERPRETATION OF RESULTS

- Direct correlation: Higher PM2.5 → lower life expectancy.
- Even moderate pollution significantly affects health.
- Highlights the urgent need for pollution control in Gabès / Ghannouch to protect human life.

ADJUSTMENTS & RECOMMENDATIONS

Adjustments

- - Incorporate multiple pollutants (SO_2, NOx, heavy metals)
- - Develop dynamic cohort models
- - Validate with local health statistics

Recommendations

- Reduce industrial emissions to lower PM2.5 and toxins.
- Implement regular air quality monitoring.
- Promote public awareness about pollution and health risks.

- Support environmental cleanup policies and stricter regulations.

References

Ben Brahim, M., et al. (2019). Environmental impact of phosphate industry in Gabès. *Journal of Environmental Management*, 245, 1-10.

Mabrouk, A., et al. (2022). Heavy metal contamination in Gabès Bay. *Marine Pollution Bulletin*, 178, 113567.

WHO (2021). WHO global air quality guidelines. Geneva: World Health Organization.

Pope, C. A., et al. (2020). Mortality risk and PM2.5 air pollution. *New England Journal of Medicine*, 382, 2513-2522.

- #WE_ARE _DYING _NOT _LYING
- SAVE_GABES

```
#THE CODDDE

import matplotlib.pyplot as plt

import pandas as pd

#input

LE_ref = 77  # reference life expectancy in years

RR_per10 = 0.08  # relative risk per 10 µg/m³ PM2.5

delta_PM = [0, 5, 15, 30]  # PM2.5 scenarios in µg/m³

# data_manupulation

RR = []

LE_adjusted = []

for pm in delta_PM:

    rr = 1 + (pm / 10) * RR_per10

    LE_new = LE_ref / rr

    RR.append(rr)

    LE_adjusted.append(LE_new)

# framedata

data = {

    "ΔPM (µg/m³)": delta_PM,

    "Relative Risk (RR)": [round(r,2) for r in RR],

    "Adjusted Life Expectancy (years)": [round(le,2) for le in LE_adjusted]

}

df = pd.DataFrame(data)

#affiche tableau

print(df)

#grah

fig, ax = plt.subplots(figsize=(8,6))
```

```
ax.plot(delta_PM, LE_adjusted, marker='o', linestyle='-', color='b')

ax.set_title("Impact of PM2.5 on Life Expectancy")

ax.set_xlabel("ΔPM (µg/m³)")

ax.set_ylabel("Adjusted Life Expectancy (years)")

ax.grid(True)
```