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ECAMED: A FEASIBILITY STUDY TO ASSESS THE IMPACT OF THE IMPLEMENTATION OF AN ECA IN THE MEDITERRANEAN SEA

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on behalf of teams from

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Introduction

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- Air pollution remains one of the most sensitive environmental fields in Europe: In its 2018 report on air quality in Europe, the European Environment Agency estimates that more than 500,000 premature deaths are due to air pollution in EU-28 (~400,000 due to $PM_{2.5}$).
- Anthropogenic sources of air pollution are various and numerous: industry, residential heating, agriculture, road and off-road traffic.
- Ship heavy fuel oil is the most harmful transport fuel in use today.

Air quality in Europe

- Because of complex chemical and dynamical processes in the atmosphere, ambient atmospheric concentrations (air quality) **are generally not linearly dependent from emissions.**
- This is particularly true for:
  - ozone which is a secondary pollutant issued from nitrogen oxides and volatile organic compounds transformation,
  - particulate matter (PM) which includes primary and secondary compounds.
- Sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3) and particulate matter (PM_{10} and $PM_{2.5}$) have harmful impacts on human health and ecosystems.

Brief presentation of the ECAMED study

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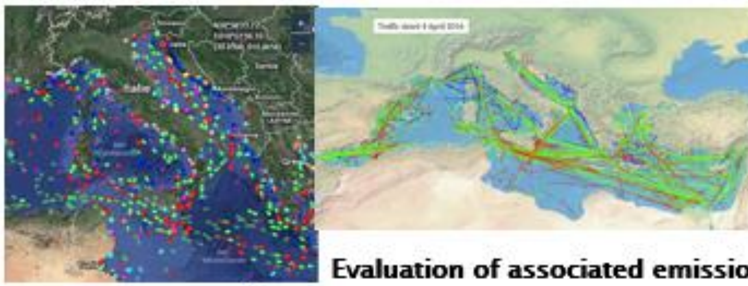
- Stakeholders of the ECAMED project:

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

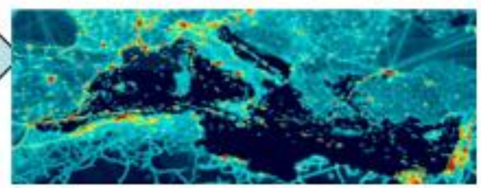
MINISTÈRE
DE LA TRANSITION
ÉCOLOGIQUE
ET SOLIDAIRE

Detailed description of ship traffic



Evaluation of associated emissions

Cerema



In-land emissions from other activity sectors
(road, off-road, industry, residential, agriculture…)
for 2015:
Official emissions reported according to the UN Convention on long range Transboundary Pollution

Reference years: 2015-2016 **with 0,5% S**
Projections :
- 0,1% S rate in fuel used
- Tier3 engines to reduce NOx emissions

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Cost–benefit analysis

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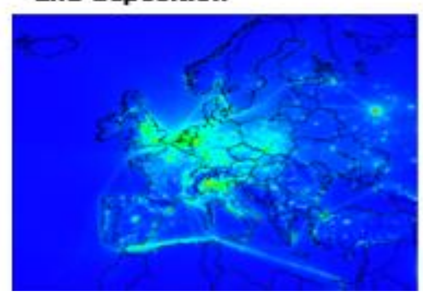
Simulated Air pollutant concentrations and deposition



INERIS
maîtriser le risque pour un développement durable

Communication and networking with stakeholders to share methodologies and results

Plan Bleu
Construisons ensemble l'avenir de la Méditerranée

Brief presentation of the ECAMED study

General methodological aspects:

- **Reference period for traffic datas:** 2015
- **Pollutants:** SO_2, NO_2, O_3, PM
- **Meteorology:** 2010
- **Domain:** all the Mediterranean Sea
- Constant traffic in scenarios
- **Emission factors from litterature**
- **Concentrations** simulated by a French consolidated chemistry-transport model (CHIMERE)
- **Mortality and morbidity:** calculated and monetized thanks to the model Alpha Risk Poll
- Qualitative analysis of the impacts on ecosystems
- **Costs** calculated thanks to fuel and technologies prices

ECAMED set-up: 4 steps

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- **Step 1:** detailed description of maritime shipping traffic in the Mediterranean Sea
- **Step 2:** calculation of current emissions and scenarios
- **Step 3:** simulation of air pollutant concentrations and deposition
- **Step 4:** costs-benefits analysis

Step 1: Detailed description of ship traffic

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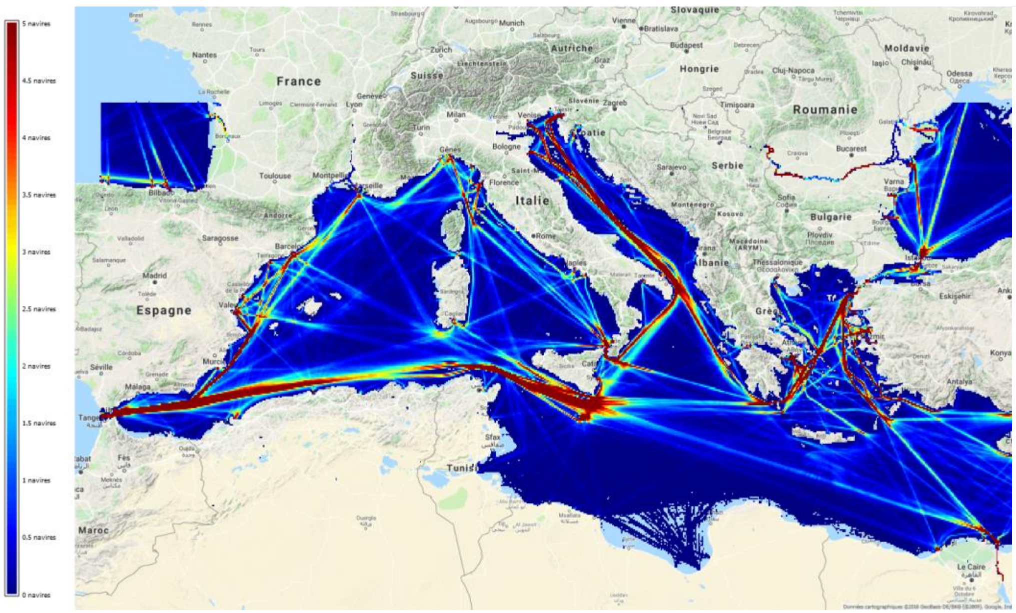
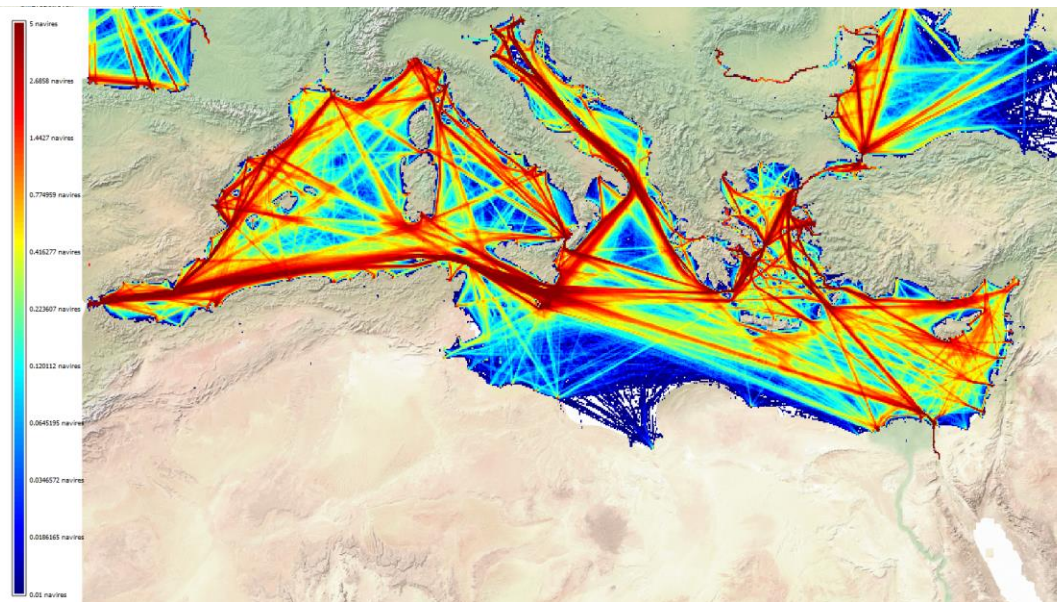
- **AIS** (Automatic identification System) databases combined with **Lloyd's register FAirPlay** allow a detailed description of maritime traffic in the Mediterranean sea (for the years 2015 and 2016)





Step 2: calculation of current emissions and scenarios

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- Equation used to calculate emissions based on AIS data from ships:

$$E(i, lon, lat, t) = \sum_j \sum_m \sum_p \left[\Delta t \sum_e \left(P_e . LF_e(lon, lat, t) . EF_{e,i,j,m,p} \right) \right]$$

- E = emission (tonnes),
- i = pollutant (NOx, NMVOC, PM, etc.)
- lon = *ship's* longitude
- lat = ship's latitude
- t= date and time of the ship on each lat/lon location data.
- j = engine type (slow-, medium-, and high-speed diesel, gas turbine and steam turbine).
- m = fuel type (bunker fuel oil, marine diesel oil/marine gas oil),
- p = the different phase of trip (cruise, hoteling, manoeuvring).
- Δt = duration since the last geographical position
- e = engine category (main, auxiliary)
- LF = engine load factor (%) at each geographical position
- P = engine nominal power (kW)
- EF = emission factor (kg/kWh) depending on type of vessel.

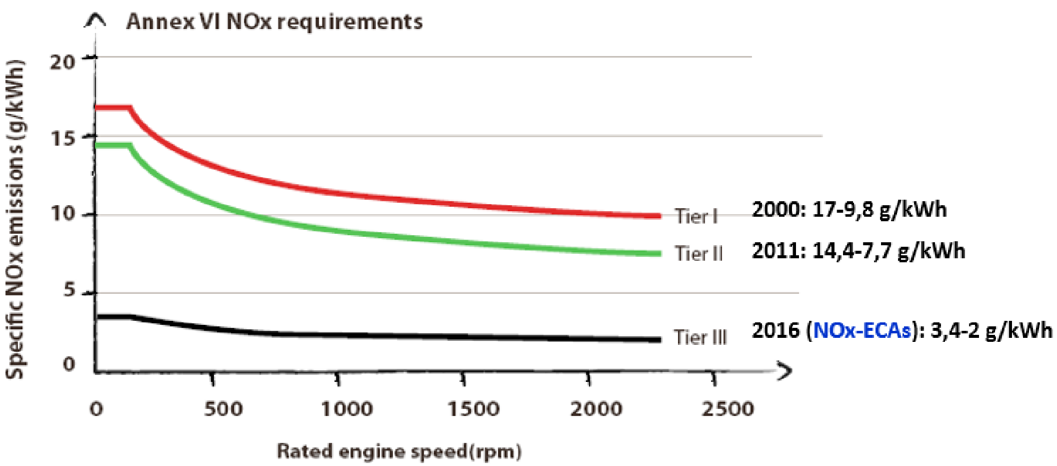
HYPOTHESIS

- Engine age= Keel laid date or Construction date-1
- Auxiliaries engines are «Medium Speed Diesel»
- Auxiliaries engines and Boilers are using the same fuel as the main engine.
- NOx EF <2000 = NOx EF 2000
- Emissions pollutants(*):
  FC, CO_2, CH_4, N_2O,
  NMVOC, NOx, SOx, CO, NH_3,
  TSP, PM_{10}, $PM_{2.5}$, BC,
  PCB, PCDD/F, HCB , BaP

(*) sources: Ricardo (2015), IVL (2004), EMEP/EEA (2016), Cooper (2005), Marpol VI

Step 2: calculation of current emissions and scenarios

- 5 scenarios :
  - Reference situation (2015)
    - *S_{max}=2.7%*
      - except for vessel more than 2h at berth in EU ports -S_{max}=0.1%,
      - and passengers vessel in EU-Exclusive Economic Zone -S_{max}=1.5%.
  - 2020 reference scenario (IMO Global Sulphur Cap 2020)
    - *S_{max}=0.5%*
      - except for vessel more than 2h at berth in EU ports -Smax=0.1%.
  - SECA scenario
    - *S_{max}=0.1%*
  - Scenario SECA/NECA 50
    - *50 % of vessel compliant with Tier III*
    - *S_{max}=0.1%*
  - Scenario SECA/NECA 100
    - *100% of vessel compliant with Tier III*
    - *S_{max}=0.1%*



Step 2: calculation of current emissions and scenarios

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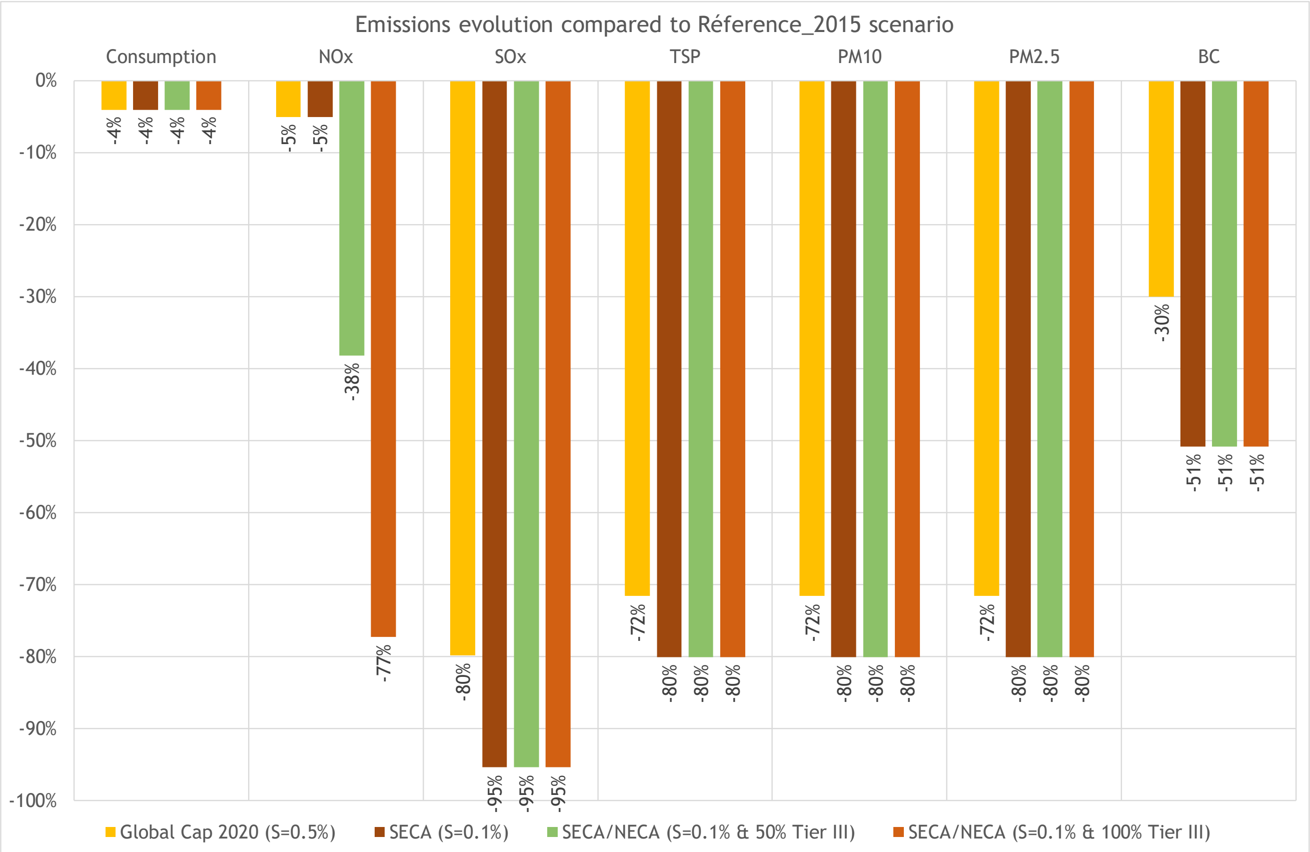
Results:

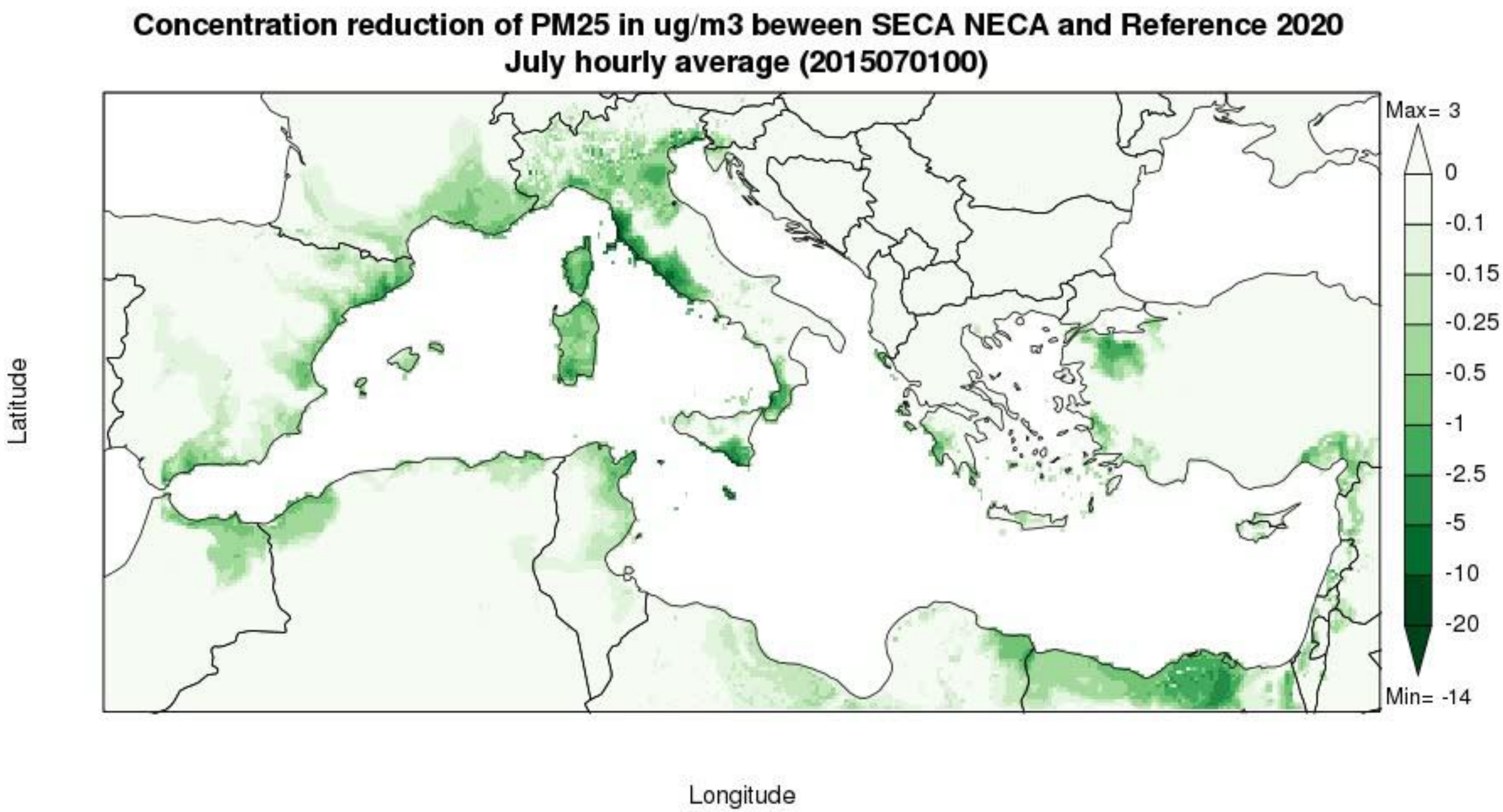
- The IMO Global Sulphur Cap 2020 will reduce the emissions of :
  - SOx by 80 %
  - PM by 72 %
  - BC by 30 %
  - NOx by 5 %
- The implementation of a SECA :
  - SOx by 95 %
  - PM by 80 %
  - BC by 51 %
- The implementation of a NECA will reduce nitrogen emissions by :
  - 38 % if 50 % of ships are TIER III
  - and 77 % if all the ships are TIER III



Global Cap 2020 SECA SECA/NECA (50% Tier III) SECA/NECA (100% Tier III)

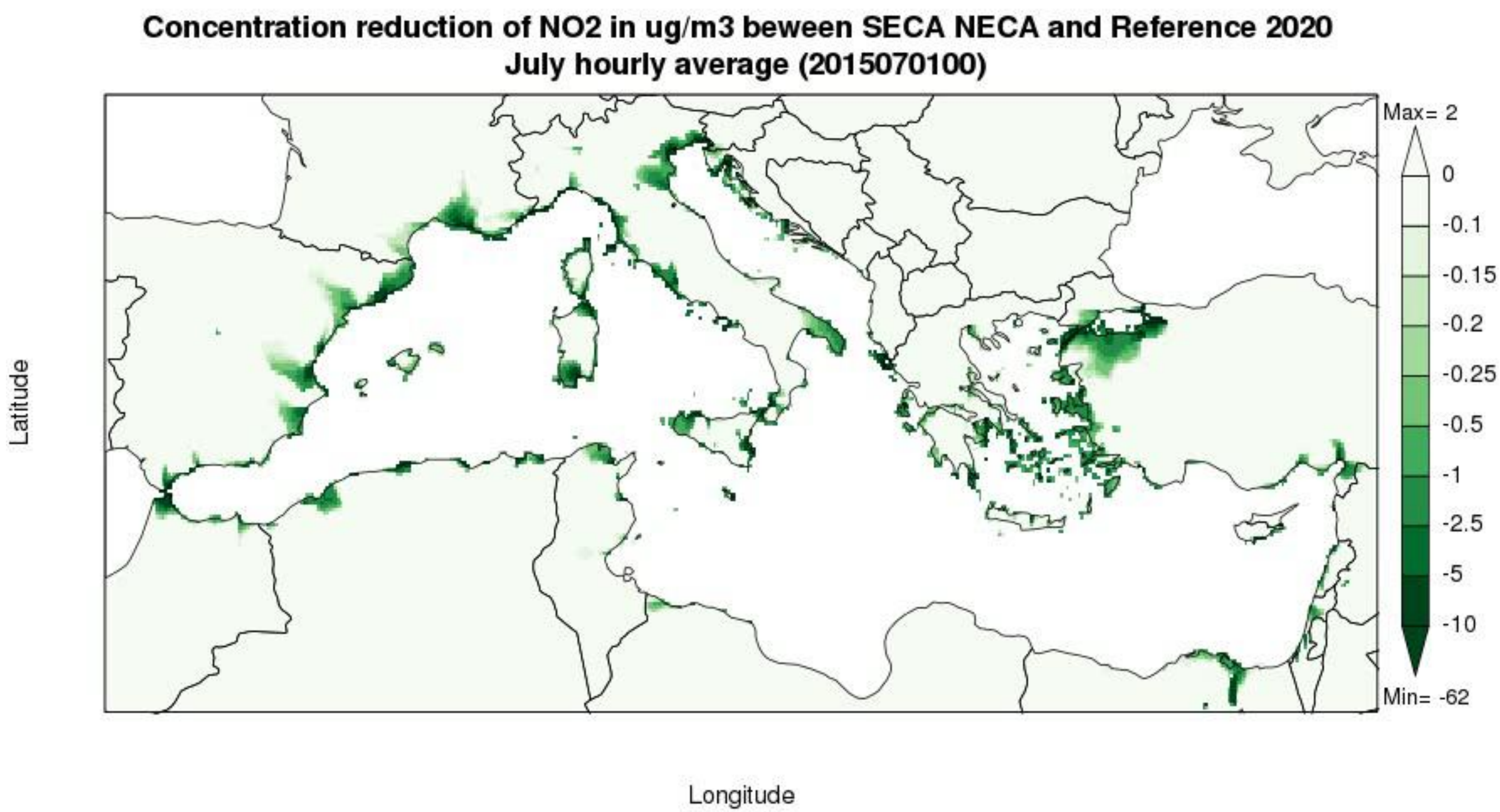
Step 3: Simulation of air pollutant concentrations and deposition

- Daily Evolution of $PM_{2.5}$ concentrations reduction (in-land) – July 2015



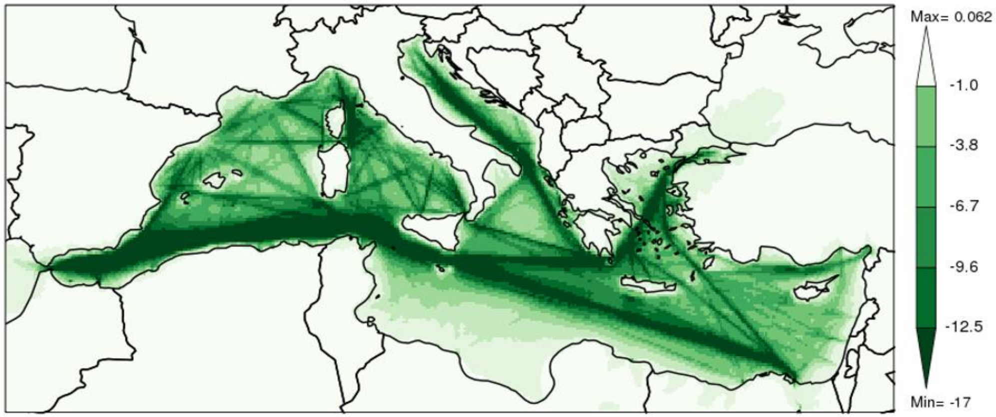
Step 3: Simulation of air pollutant concentrations and deposition

- Daily Evolution of NO_2 concentrations reduction (in-land) – July 2015



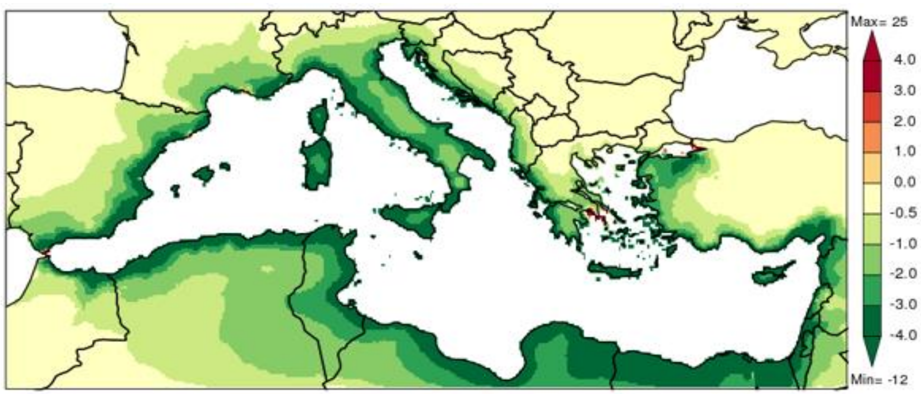
Step 3: Simulation of air pollutant concentrations and deposition

- Impacts on annual means: differences between 2020 Global cap and SECA-NECA



Absolute differences of NO_2 annual averages

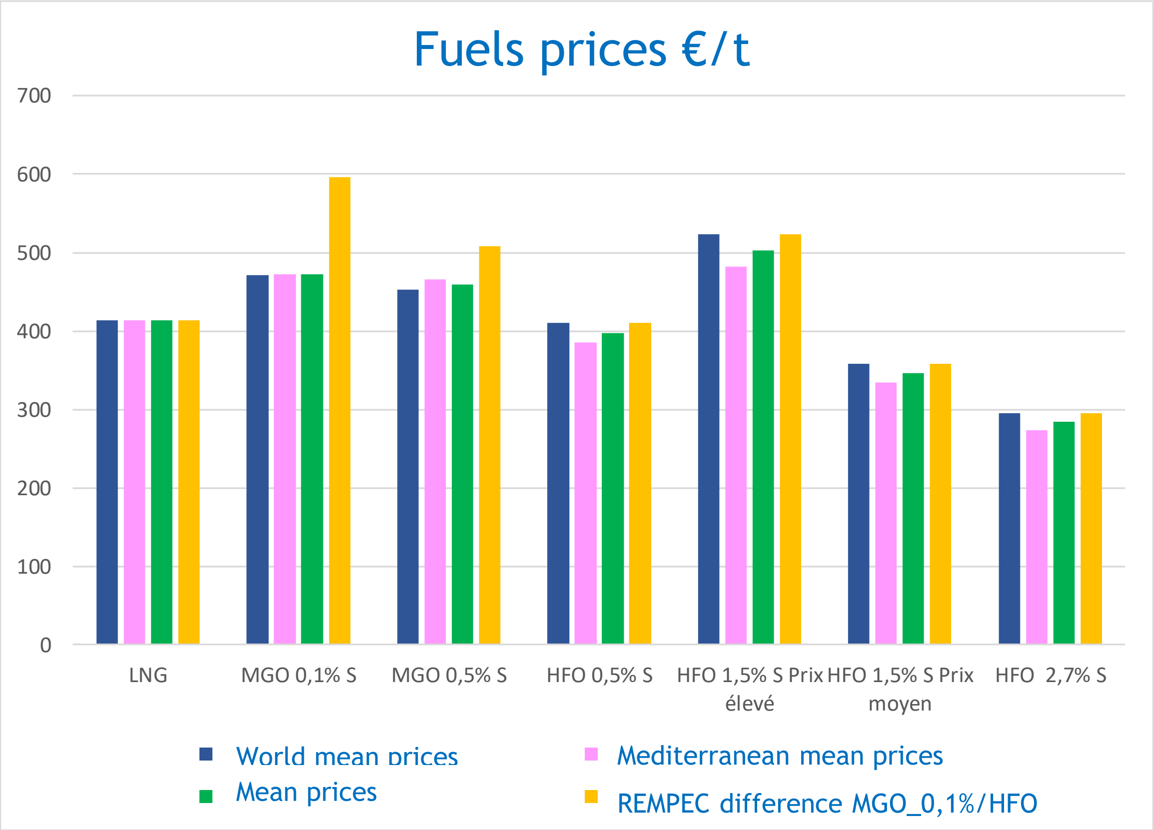
Absolute differences of $PM_{2.5}$ annual averages

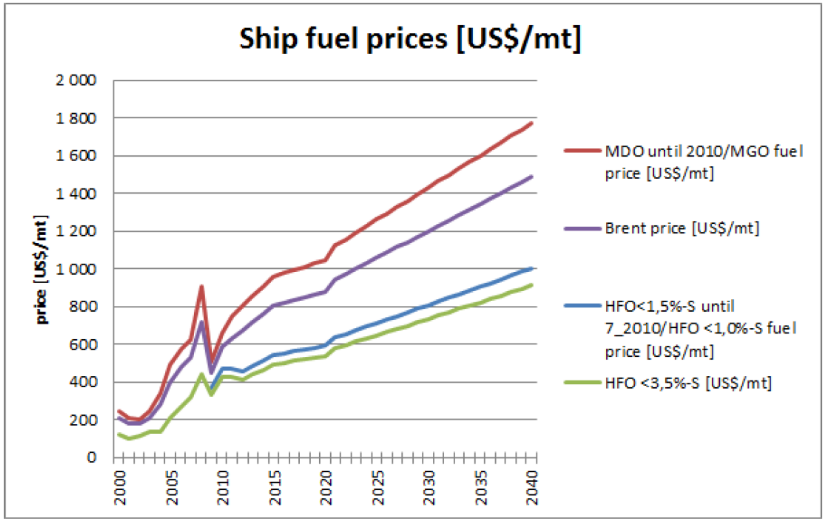


Absolute differences of O_3 annual averages

Step 4: Cost-benefits analysis

- Fuel prices used in the different scenarios calculations





Step 4: Cost-benefits analysis

- Synthesis of health impacts (mortality and morbidity) considered in the ECAMED Health Impact Assessment and their monetary unit values
- Alpha-RiskPoll tool used – developed by EMRC (Mike Holland) for use in evaluation of health benefits of European air policy Directives
- Use of identical monetary values in all countries for the ECAMED study
- All results presented are for 2015
- All monetary values expressed in € price base 2015

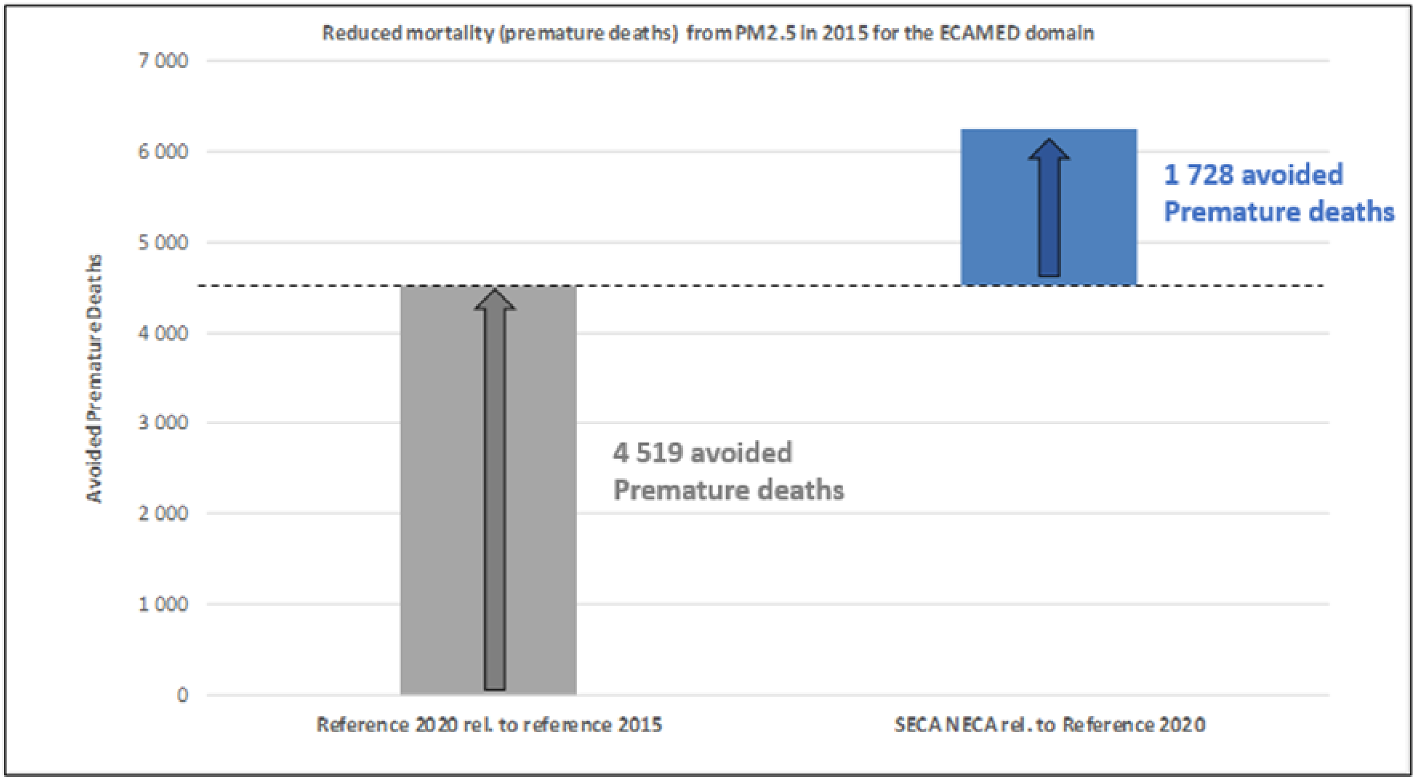
Health impact	Impact unit	Pollutant	Unit valuation (€ price base 2015)
Acute Mortality (All ages) median VOLY*	Premature deaths	O_3	66 728
Respiratory hospital admissions (>64)	Cases		2 567
Cardiovascular hospital admissions (>64)	Cases		2 567
Minor Restricted Activity Days (MRADs all ages)	Days		49
Chronic Mortality (All ages) LYL median VOLY	Life years lost	$PM_{2.5}$	66 728
Chronic Mortality (30yr +) deaths mean VSL**	Premature deaths		2 567 364
Infant Mortality (0-1yr) mean VSL	Premature deaths		3 851 047
Chronic Bronchitis (27yr +)	Cases		61 987
Bronchitis in children aged 6 to 12	Cases		680
Respiratory Hospital Admissions (All ages)	Cases		2 567
Cardiac Hospital Admissions All ages)	Cases		2 567
Restricted Activity Days (all ages)	Days		106
Asthma symptom days (children 5-19yr)	Days		49
Lost working days (15-64 years)	Days		150
Bronchitis in children aged 5 to 14	Cases	NO_2	680
Respiratory Hospital Admissions (All ages)	Cases		2 567
Chronic Mortality (All ages) LYL median VOLY	Life years lost		66 728
Chronic Mortality (30yr +) deaths mean VSL	Premature deaths		2 567 364

(*) VOLY = Value of Life Year ; (**) VSL = Value of Statistical Life ; values for the willingness to pay by society to reduce the risk of premature mortality.

Concentrations response functions according to WHO/Europe (2013) - HRAPIE study - Health Risks of Air Pollution in Europe. 67% of NO_2 chronic mortality accounted for in monetary cost (benefit) to avoid risk of double counting with $PM_{2.5}$ chronic mortality.

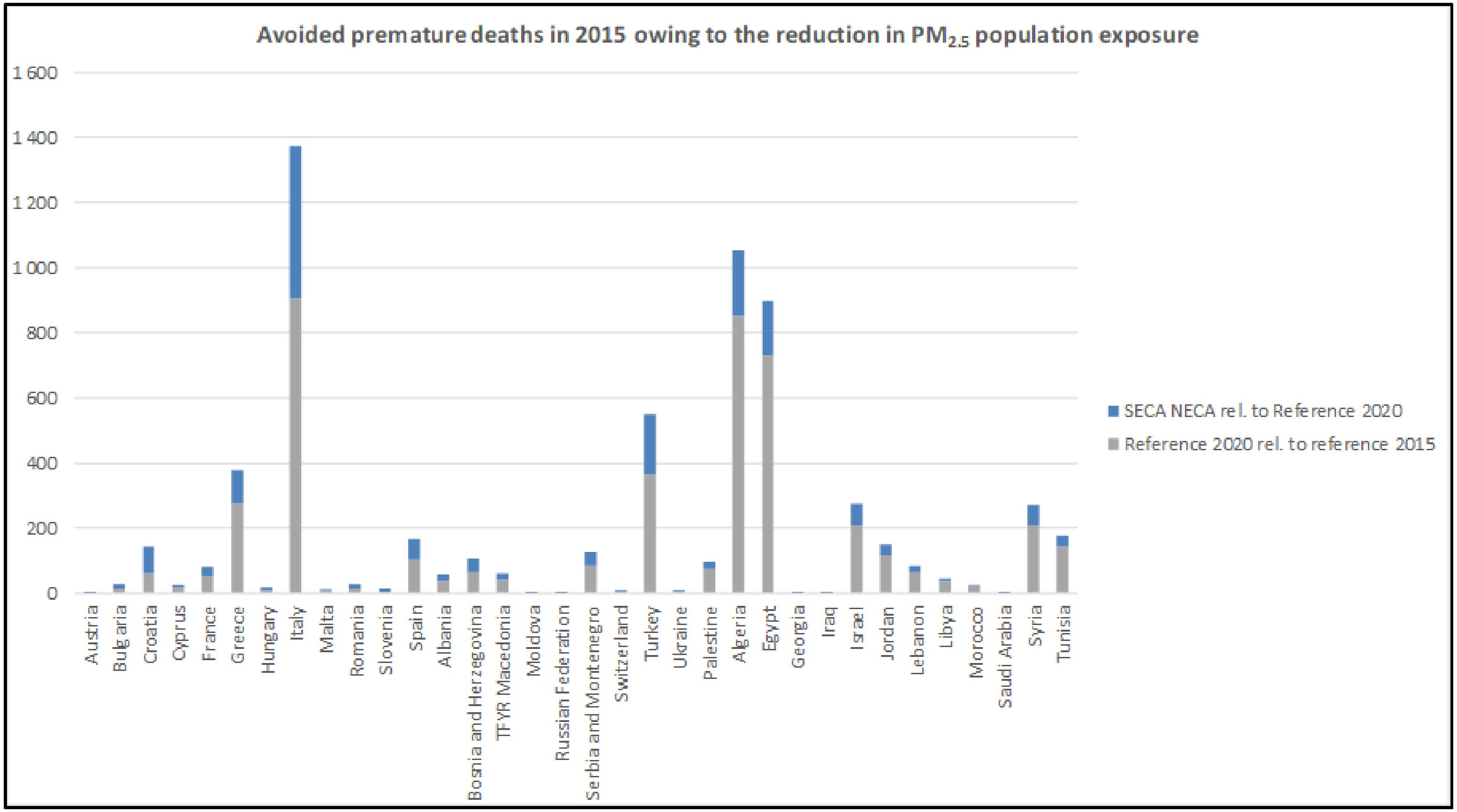
Step 4: Cost-benefits analysis

- Reduced mortality (premature deaths) from $PM_{2.5}$



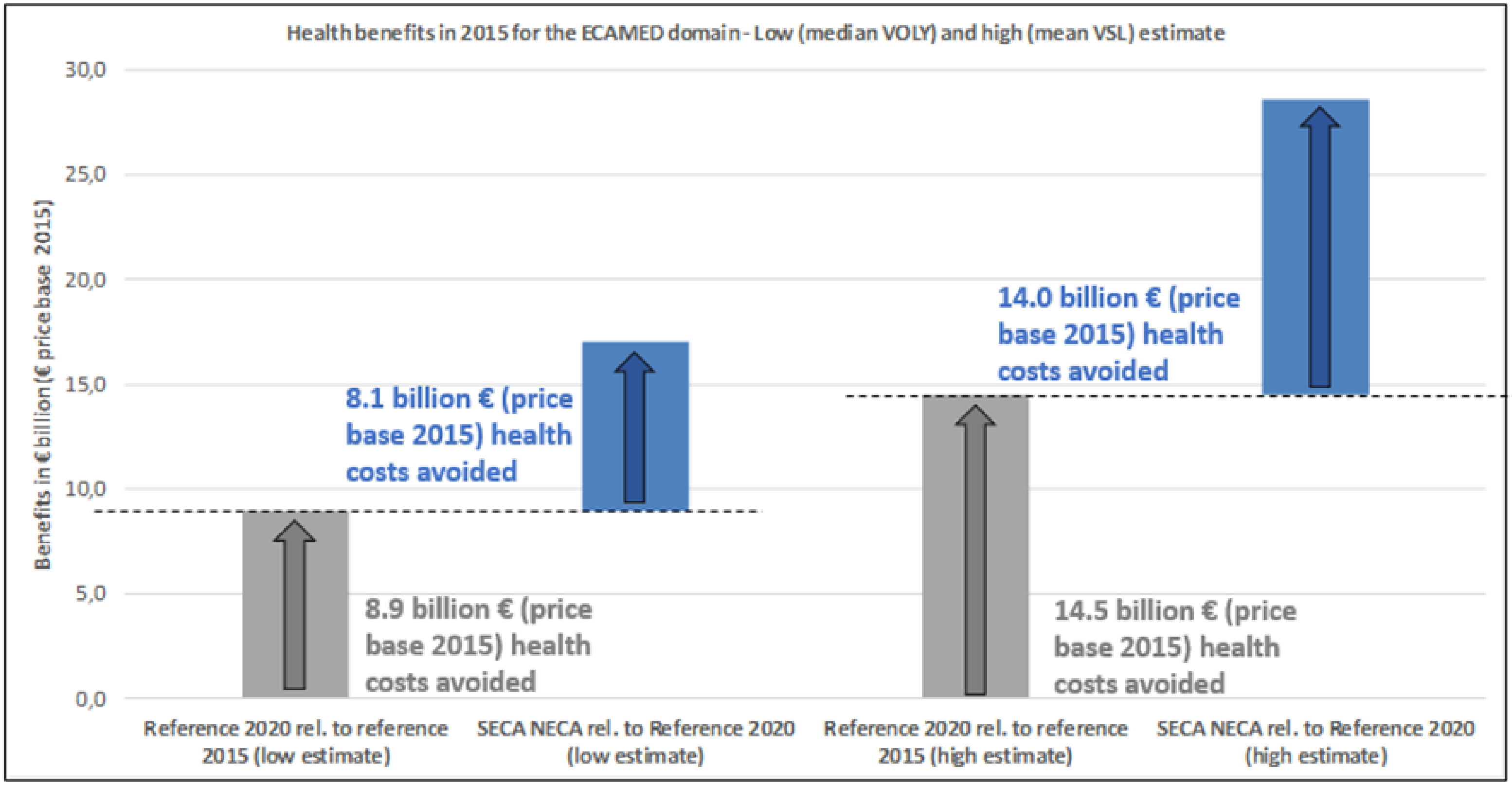
Step 4: Cost-benefits analysis

- Avoided premature deaths in 2015 owing to the reduction in $PM_{2.5}$ population exposure



Step 4: Cost-benefits analysis

- Health benefits for the ECAMED domain



VOLY: **V**alue **O**f **L**ife **Y**ear

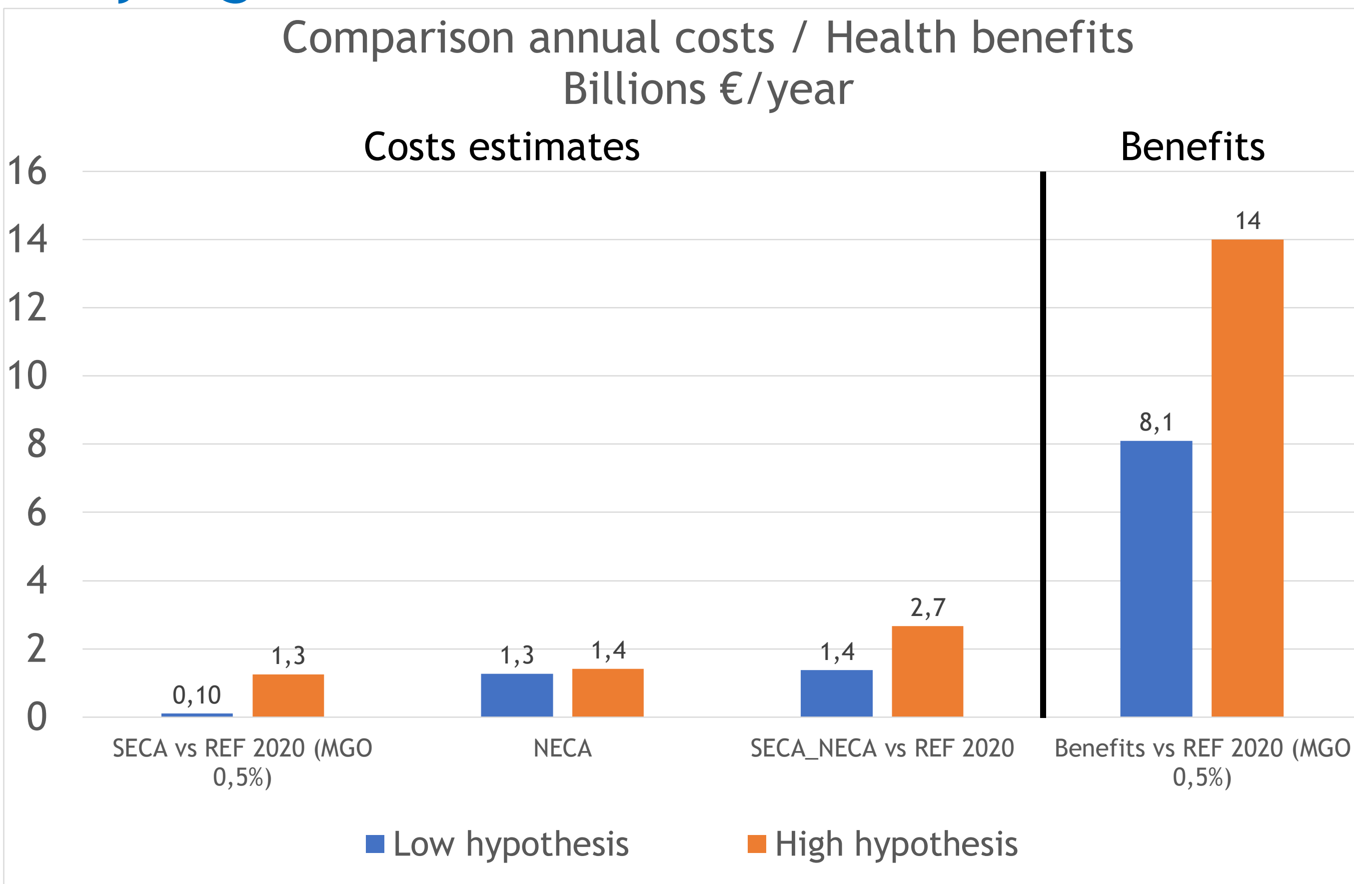
VSL: **V**alue of **S**tatistical **L**ife

Step 4: Cost-benefits analysis

- SECA NECA related to Reference 2020 - Benefit (in M€)

Step 4: Cost-benefits analysis

- Whatever the mitigation scenario, benefits are always significantly higher than the costs



Conclusion

- In the worst-case scenario, **health benefits of implementing a SECA/NECA are 3 times higher than costs**,
- France hopes that the French study, the EU study and the REMPEC one will lead to **a rise of awareness about the important need for an ECA** in the Mediterranean Sea.
- Report available here: https://www.ecologique-solidaire.gouv.fr/sites/default/files/R_DRC-19-168862-00408A_ECAMED_final_Report_V5.pdf

Next steps

- **2019:** Informal preparatory work for a decision of the European Union Council- Diplomatic Initiatives to Mediterranean Countries
- **2nd semester 2019:** decision of the European Union Council
- **March 2020:** submission to IMO
- **April 2020:** approval of the ECA by IMO (1rst phase of the decision)
- **Autumn 2020 or July 2021:** adoption of the ECA by IMO (2nd phase of the decision) - Entry into force fixed during the negotiations
- **2022:** ECA zone entry into force target

Thank you for your attention

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