POLLUTION FROM MARITIME SHIPPING INDUSTRY

Effects on Air Quality & Climate Change

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POLLUTION FROM MARITIME SHIPPING INDUSTRY
EFFECTS ON AIR QUALITY & CLIMATE CHANGE

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PRESENTATION OUTLINE

1. BACKGROUND INFORMATION ON AIR POLLUTION AND GHGs
2. EMISSIONS FROM TRANSPORT SECTOR
3. INTERNATIONAL LEGAL FRAMEWORK
4. AIR POLLUTION AND CLIMATE CHANGE IMPACTS
5. MITIGATION POLICY
6. CONCLUSION
1. BACKGROUND INFORMATION ON AIR POLLUTION AND GREENHOUSE GASES (GHG)
Introduction

- The earth has been in existence for over 4.5 billion years?
- Earth climate is subjected multiple from natural forcings, from changes in our orbit around sun and volcanic eruptions;
- Global Climate has experienced natural variation cycles (colder and warmer conditions);
- Cycles encounter tipping points pushing the environment to extreme;
- Global warming concern is introduced by human forcing;
- Human forcing has increased the rate of global warming through greenhouse effect.

Fig. S18. Global temperature (left scale) and GHG forcing (right scale) due to $\text{CO}_2$, $\text{CH}_4$ and $\text{N}_2\text{O}$ from Vostok ice core (11, 15). Ratio of temperature and forcing scales is 1.5°C per W/m². Time scale is expanded in the extension to recent years. Modern forcings include human-made aerosols, volcanic aerosols and solar irradiance (5). GHG forcing zero point is the mean for 10-8 ky before present. Net climate forcing and modern temperature zero points are at 1850. The implicit presumption that the positive GHG forcing at 1850 is largely offset by negative human-made forcings (6) is supported by the lack of rapid climate change at that time.
Greenhouse Gas (GHG) refers to any gaseous compound in the atmosphere that is capable of absorbing the Sun’s infrared radiation, thereby trapping and holding heat in the atmosphere.

Over 30 atmospheric greenhouse gases, KP1 and UNFCCC focus on 6:

- Carbon dioxide (CO$_2$)
- Methane (CH$_4$)
- Nitrous oxide (N$_2$O)
- Perfluorocarbons (C$_x$F$_x$)
- Hydrofluorocarbons (HFCs)
- Sulphur hexafluoride (SF$_6$)

Other key GHG not covered:

- Ozone (O$_3$)
- Water vapor (H$_2$O)

Relevant to bio-carbon, fossil fuels & industrial projects:

- Perfluorocarbons (C$_x$F$_x$)
- Hydrofluorocarbons (HFCs)

Relevant to industrial projects:

- Carbon dioxide (CO$_2$)
- Methane (CH$_4$)
- Nitrous oxide (N$_2$O)
GHGs and the Greenhouse Effect

1. Solar radiation passes through the clear atmosphere. Incoming solar radiation: 343 Watt per m²

2. Net incoming solar radiation: 240 Watt per m²

3. Some solar radiation is reflected by the atmosphere and earth’s surface. Outgoing solar radiation: 103 Watt per m²

4. Solar energy is absorbed by the earth’s surface and warms it... 148 Watt per m²

5. Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules. The direct effect is the warming of the earth’s surface and the troposphere.

6. Some of the infrared radiation passes through the atmosphere and is lost in space. Net outgoing infrared radiation: 240 Watt per m²

Surface gains more heat and infrared radiation is emitted again.

Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Warrington, Climate change 1995. The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UMEP and WHO, Cambridge university press, 1996.
Global warming potential of KP/UNFCCC GHGs

Global warming potential (GWP) is a relative measure of how much heat a greenhouse gas traps in the atmosphere by a similar mass of carbon dioxide. A GWP is calculated over a specific time interval, commonly 20, 100, or 500 years.

<table>
<thead>
<tr>
<th>Greenhouse Gas (GHG)</th>
<th>Global Warming Potential (GWP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>1</td>
</tr>
<tr>
<td>Methane</td>
<td>25</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>310</td>
</tr>
<tr>
<td>Perfluorocarbons</td>
<td>6,500 - 9,200</td>
</tr>
<tr>
<td>Hydrofluorocarbons</td>
<td>140 - 11,700</td>
</tr>
<tr>
<td>Sulphur hexafluoride</td>
<td>23,900</td>
</tr>
</tbody>
</table>

Relative scale - everything is measured relative to CO₂ (CO₂equivance).

e.g. methane is 25 times more potent as a greenhouse gas than CO₂

1t CH₄ = 25t CO₂e
GHG emissions by sector

Changes in GHG since industrial revolution (IPCC 2007)
Stabilization of atmospheric concentrations requires moving away from the baseline—regardless of the mitigation goal.
Paris Agreement in Context

- 12 December 2015, 197 parties to the Convention have agreed the first global international climate change agreement.
- 193 countries have signed and 170 ratified
- On 5 October 2016, the threshold for entry into force of the Paris Agreement was achieved
- Entered into force on 4th of November 2016 a month after meeting the threshold 55 Parties to the Convention accounting in total for at least an estimated 55 % of the total global greenhouse gas emissions have deposited their instruments of ratification
- Considered an international treaty under the Vienna Convention.
- Employs a “hybrid legal structure,” with both legally binding and nonbinding components
- Employs a top-down, rules-based system and a bottom-up system of pledge and review.
- Kenya ratified on the 28th of December 2016
The Agreement also adopts an ambitious emission reduction pathway consistent with holding the increase in the global average temperature to well below 2°C and while working towards 1.5°C above preindustrial levels.

Source: M. Meinshausen, Australian-German Climate & Energy College, The University of Melbourne, climatecollege.unimelb.edu.au
Paris Agreement - long term global goal

Articles 3 and 4 of the Paris Agreement require that all Parties undertake and communicate ambitious effort through their *Intended Nationally Determined Contributions (INDC)* and acknowledges the need for early peaking of emissions.

Article 7 focuses on enhancing adaptation efforts.

Kenya’s 30% emission reduction by 2030 target does not include emission from maritime.

Source: M. Meinshausen, Australian-German Climate & Energy College, The University of Melbourne, climatecollege.unimelb.edu.au
Air Pollution including (non-GHG)

- **Air pollution** refers to the introduction into the environment in **high concentration** of any chemical, physical or biological matter in a way that interferes with the natural elements of the atmosphere. These compounds may be found in the air in three major forms:
  - Gaseous (as gases),
  - Solid form (as particulate matter suspended in the air)
  - Liquid (aqueous);

- Sources of air pollution: **anthropogenic** (burning of fossil fuels and removal of sinks) or **natural** (Volcanic activities, Wildfires, Microbial decaying processes, Radioactive decay processes)

- Air Pollutants can be categorized into two:
  - **Primary Pollutants** - emitted directly from the source into the atmosphere.
  - **Secondary Pollutants** - formed in the atmosphere as a result of chemical reactions of primary pollutants and normal atmospheric conditions
Common air pollutants

- Hydrocarbons (HC, incl. VOCs - benzene, 1,3-butadiene, aldehydes, and polycyclic aromatic hydrocarbons);
- PM2.5, PM10
- Nitrogen Dioxide (NO2)
- Pb (where Leaded fuel is still in use);
- Ground ozone (O3);
- Carbon Monoxide (CO);
- Sulphur Dioxide (SO2)

- WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide

- National Ambient Air Quality Standards
Common Air Pollutants and their Sources

Source: http://facts.net/air-pollution/
2. EMISSIONS FROM TRANSPORT SECTOR
14% primarily involve fossil fuels burned for road, rail, air, and marine transportation; 

(95%) of the world's transportation energy comes from petroleum-based fuels, largely gasoline and diesel.

Source: IPCC (2014); based on global emissions from 2010.
Greenhouse gas (GHG) emissions from the transport sector have more than doubled since 1970, and have increased at a faster rate than any other energy end-use sector.

Source: IPCC 2014
Emissions from maritime shipping

- Shipping sector is responsible of close to 3 % of global emissions (IMO GHG Study);
- GHG from shipping could rise to 17% by 2030 if unabated;
- Depending on future economic and energy developments, BaU scenarios project an increase by 50% to 250% in the period to 2050;
- Increasing emissions will hamper the world's capacity to meet the world's capacity to meet the global goal of the Paris Accord;
- Industry should further improve the fuel efficiency and carbon footprint of its vessels.

Refer to 3rd GHG Study for International Maritime Shipping.
3. INTERNATIONAL LEGAL FRAMEWORK
MARPOL Convention 73/78

- International convention for the prevent of pollution from ships (MARPOL);
- It covers accidental and operational oil pollution as well as pollution by chemicals, goods in packaged form, sewage, garbage and air pollution
- It was modified by the protocol in 1978 relating to (MARPOL 73/78)

Marpol Covers;
- Annex I – Oil
- Annex II – Noxious liquid chemicals
- Annex IV – Sewage
- Annex V – Ballast water
- Annex VI – Air pollution and greenhouse emission
Annex VI - Air pollution and greenhouse emissions

- NOX Technical Code
- Guidelines

- Regulations
  - Regulation 12: Ozone Depleting Substance;
  - Regulation 13: NOx
  - Regulation 14 SOX
  - Regulation 15: VOCs
  - Regulation 16: Use of incinerators
  - Regulation 18: Fuel Quality
Climate Change Regime

UNFCCC 1992 drawn up at 1992 Rio Earth Summit

- Came into force in 1994
- Framework Convention
- Ratified by 197 countries
- Objective is to stabilise GHG emissions

Kyoto Protocol (KP) 1997

- Came into force in 2005, 192 parties
- Developed to meet the ultimate objective of the UNFCCC which is to “stabilize GHG concentrations in the atmosphere at a level that would prevent anthropogenic interference with the climate system”…. through quantified emission targets within a specified timeframe.

- KP First commitment period (KP1): 2008-2012 (prescribed emission reduction targets for developed countries)
- Emissions from international aviation and shipping are treated separately in Article 2.2
- 2015 Paris Agreement comes into effect in 2016 – Not include bunker fuels
International Legal Regimes Cont...

- Nairobi Convention and its protocols (western Indian Ocean States)
- Sustainable Development Goals SDG - 13 and 14;
4. AIR POLLUTION AND CLIMATE CHANGE IMPACTS
Environmental Effects of Air Pollution - Regional Impacts

- **Acidification**: soil chemistry, ocean ecology (SOx, NOx, NHx)

- **Eutrophication**: algal blooms, biodiversity (NOx, NHx)

- **Excess ozone**: health, vegetation, climate (NOx, VOC, CO)

- **Aerosols**: health, climate (SOx, NOx, NHx, VOC,..)

- **Corrosion**: (SOx, H+, O3, NOx, )

- **Toxic species**: (Hg, Pb, PCB ...)

![Diagram showing the effects of air pollution on natural and built environments.](image-url)
Outdoor air pollution was associated with 3.7 million premature deaths in 2012.
Oceans absorbed 80 percent of the heat added to the Earth’s system by climate change. The climate impacts on oceans include warming, acidification, sea level rise etc.
Social Impacts- AR4

- Access to water
  - 75 to 250 million Africans will experience water stress by 2020

- Food security
  - 6.2 million Ethiopians are starving today

- Health
  - Malaria transmission areas could double

- Migration
  - Due to sea-level rise, drought and flooding
Economical Impacts - AR4

- **Agriculture**
  - Possible yield reduction in agriculture of 50% by 2020
  - Arid and semi-arid land increase by 5% to 8% by 2080s

- **Fisheries**
  - Productivity in some areas is projected to decrease up to 60%

- **Tourism**
  - At risk particularly in mountain regions and coastal zones

- **Energy**
  - USD 102 million lost in Zambia hydropower

- **Infrastructure**
  - Egypt - 5 to 10% GDP sea-level rise

- **Health**
  - Malaria - USD 12 billion annually
Number of disasters per year

All disasters include: drought, earthquake, extreme temperatures, famine, flood, insect infestation, slides, volcanic eruption, wave and surge, wild fires, wind storm.

Trends in number of reported disasters

Much of the increase in the number of hazardous events reported is probably due to significant improvements in information access and also to population growth, but the number of floods and cyclones reported is still rising compared to earthquakes. Is global warming affecting the frequency of natural hazards?

Sea surface temperature warming

Source: NASA-GISS
Sea Level Rise

- Submergence of coastal cities
- Coastal erosion
- Floods
- Salt water intrusion
- Loss of wetlands

Estimates put the rate of sea level rise in the last 20 years at roughly 3.2 mm a year, which is almost twice the rate of the 80 years prior to that.

Source: oceanbites.org
Disappearing snows

- The disappearing Snows of African mountains.

The disappearing snow of Kilimanjaro.
Greenland and Sea Level Rise

Number of melt days on the Greenland ice sheet on average (1979-2007) and last year (2012). Source: National Snow and Ice Data Centre
Disappearance of African Lakes

The Disappearance of Lake Chad in Africa

1963

1973

1987

1997

2001

Source: This collection of maps has been drawn after a series of satellite images provided by NASA Goddard Space Flight Center, available at:
5. MITIGATION POLICY
Mitigation policy tools

Must include: **Responsive and prevention tools**

| Price-based instruments | Taxes on CO\textsubscript{2} emissions.  
| | Taxes on inputs or outputs of process (energy or vehicles).  
| | Removal of environmentally harmful subsidies (e.g. for fossil fuels).  
| | Subsidies for emissions-reducing activities.  
| | Emissions trading systems (cap-and-trade or Baseline-and-credit).  |

| Command and control regulations | Technology standards.  
| | Performance standards.  
| | Prohibition or mandating of certain products or practices.  
| | Reporting requirements.  
| | Requirements for operating certification.  
| | Land-use planning, zoning.  |

| Technology support policies | A robust intellectual property rights system.  
| | Public and private R&D funding.  
| | Public procurement of low-carbon products and services.  
| | Green certificates (e.g. renewable portfolio standard).  
| | Feed-in tariffs for electricity from renewable.  
| | Public investment in infrastructure for new low-carbon technologies.  
| | Policies to remove financial barriers to green technology (loans, revolving funds, direct financial transfers, preferential tax treatment).  
| | Capacity building for the workforce, infrastructure development.  |

| Information and voluntary approaches | Rating and labelling programmes.  
| | Public information campaigns.  
| | Education and training.  
| | Product certification and labelling.  
| | Award schemes.  |

Kenya - National legal framework -shipping

- Merchants Shipping Act (subsidiary legislation)
  - Merchant Shipping (Fees) Regulations -revoked by L.N. 192/2011
  - Merchant Shipping (Application of Safety Convention, 1974) Order, 2004
  - Merchant Shipping (Maritime Service Providers) Regulations, 2011
  - Merchant Shipping (Fees) Regulations, 2011
  - Merchant Shipping (Port State Control) Regulations, 2011
  - Merchant Shipping (Licensing of Vessels) Regulations, 2012

Integrated Coastal Zone Management (ICZM) Policy and ICZM Action Plan 2015;
National Legal Framework for climate change in Kenya for mitigation

- Constitution of Kenya 2010
- Kenya Vision 2030
- Kenya Climate Change Response Strategy 2010
- National Climate Change Action Plan
- Climate Change Act 2016 – Includes IMO, ICAO, PA
  - Annual reporting required;
  - NCCC chaired by president
- Climate Change Framework Policy
- Climate Finance Policy
- Air quality Regulations 2014
- Sector specific legislations
Climate change plans

- National Climate Change Response Strategy, 2010
- National Climate Change Action Plan, 2018-2022 -linked to MTP III, CIDPII, PA and SDGs
- Coastal? marine spatial planning, blue economy strategy?
  - Green Economy Strategy and Implementation Plan (GESIP)
  - Nationally Determined Contribution (NDC)
6. CONCLUSION

- Maritime shipping sector has a significant role to play in the attainment long-term global goal of attaining 2 degree or 1.5 degrees by 2100;
- Strong policy signal needed at international and national level to spur mitigation efforts;
- Public and private finance for implementation of Annex IV;
- Plan for domestication of Annex I to V of the Marpol 73/78 Convention;
- Explore market-based mechanisms.

Events in Kenya
- UNEA 3 2017 (concluded) - Pollution;
- Blue Economy Conference 2018;
- Oceans Conference 2020;
THANK YOU!
MTCC-Africa Consortium Members

Jomo Kenyatta University of Agriculture and Technology (JKUAT)

Kenya Maritime Authority (KMA)

Kenya Ports Authority (KPA)

Host Institution