Military Emissions Gap Conference 2023

MILITARY AND CONFLICT GHG EMISSIONS: FROM UNDERSTANDING TO MITIGATION

Tuesday 26 September, University of Oxford, and online

CONCRETE IMPACTS

Conflict and Environment Observatory

Scientists for Global Responsibility

UNIVERSITY OF OXFORD

Queen Mary University of London

The Minor Foundation

Military GHG emissions – status and needs

Linsey Cottrell

Environmental Policy Officer - Conflict and Environment Observatory

THE MILITARY EMISSIONS GAP

Conflict and Environment Observatory

Lancaster University

Durham University

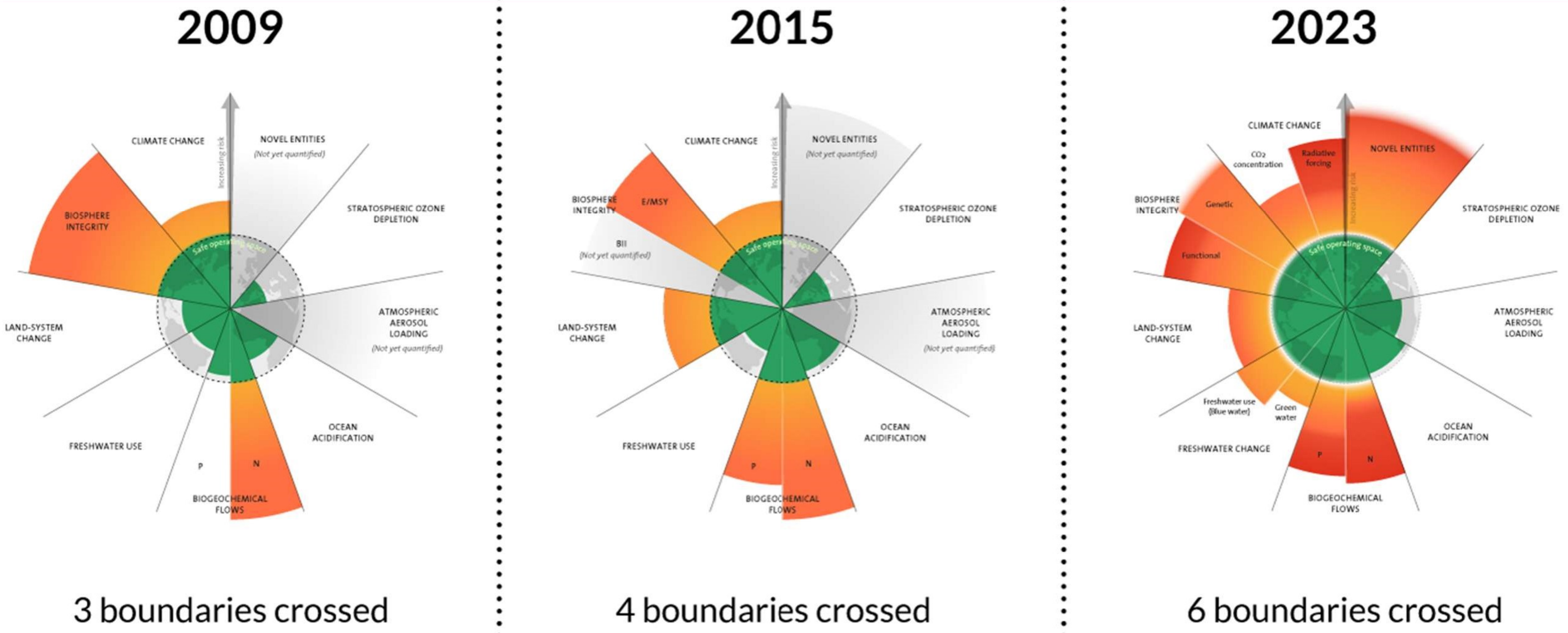
The Minor Foundation for Major Challenges

Conflict and Environment Observatory

CEOBS is a UK charity working to increase the protection of people and ecosystems from the impact of armed conflicts and military activities

www.ceobs.org

Stockholm Resilience Centre



Credit: Azote for Stockholm Resilience Centre, Stockholm University. Based on Richardson et al. 2023, Steffen et al. 2015, and Rockström et al. 2009

https://tinyurl.com/yck82whm

The Minor Foundation
for Major Challenges

Why focus on the military?

- They are huge consumers of **fossil fuels**
- We **know relatively little** about their overall impact on global GHG emissions
- This **needs to change**, with improved data, transparency and reporting

Conflict and Environment Observatory

The Minor Foundation for Major Challenges

Purpose

- Review of UNFCCC data submitted
- Help understand what is already being reported
- Where are the gaps?
- What is needed?

www.militaryemissions.org

Conflict and Environment Observatory

The Minor Foundation for Major Challenges

United Nations
Climate Change

Time series - Annex I | Detailed data by Party | Comparison by Category | Comparison by Gas | GHG profiles | Global map - Annex I | Flexible queries | User-defined indicators | Compilation and Accounting Data

Greenhouse Gas Inventory Data - Detailed data by Party

Please select Party, Inventory Year, Category, Gas and Unit.

Annex I

Base year (Convention), 1990 and last year

...............1.A.5 Other (Not specified elsewhere)

Aggregate GHGs

Mt CO_2 equivalent

Query results for — Party: Annex I — Years: Base year (Convention), 1990 and last year — Category: 1.A.5 Other (Not specified elsewhere) — Gas: Aggregate GHGs — Unit: Mt CO_2 equivalent

Export to Excel | Export to CSV | Printer Friendly Version

Category	Base year	1990	Last Inventory Year (2020)
1.A.5 Other (Not specified elsewhere)	**551.50**	**545.08**	**224.59**
1.A.5.a Stationary	486.81	480.44	202.37
1.A.5.b Mobile	64.69	64.63	22.21

Conflict and Environment Observatory

The Minor Foundation for Major Challenges

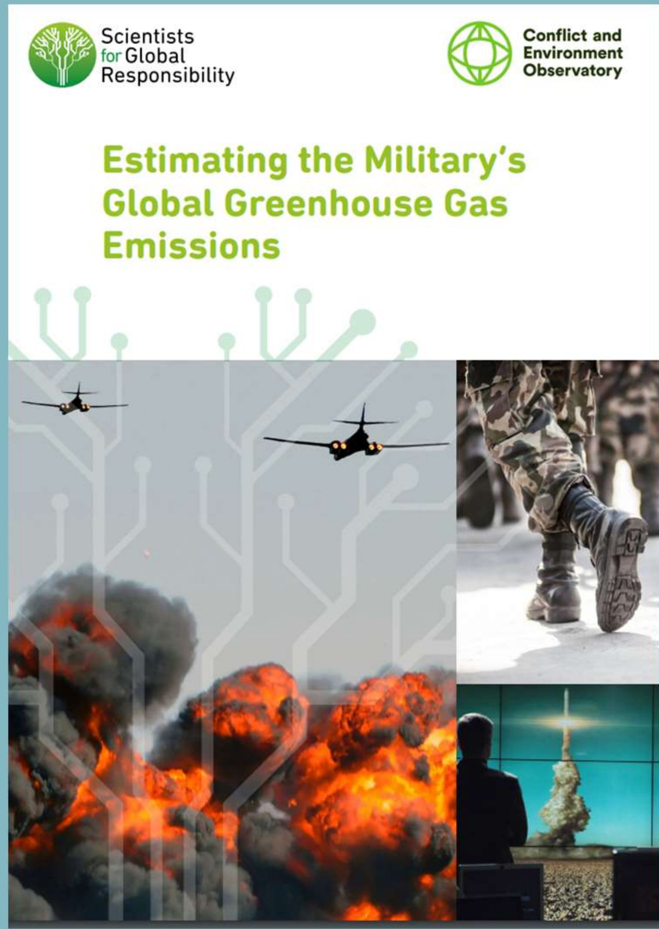
Key points

- **Spending up – US$ 2.42 trillion in 2022**
- **UNFCCC data submitted in 2023 (2021)**
- **Annex 1 countries - only 5 reported in line with UNFCCC obligations**
- **Non Annex 1 countries included those with large military expenditure – e.g. China, India, Saudi Arabia, South Korea, Brazil, Israel**

The Minor Foundation
for Major Challenges

What is the global contribution?

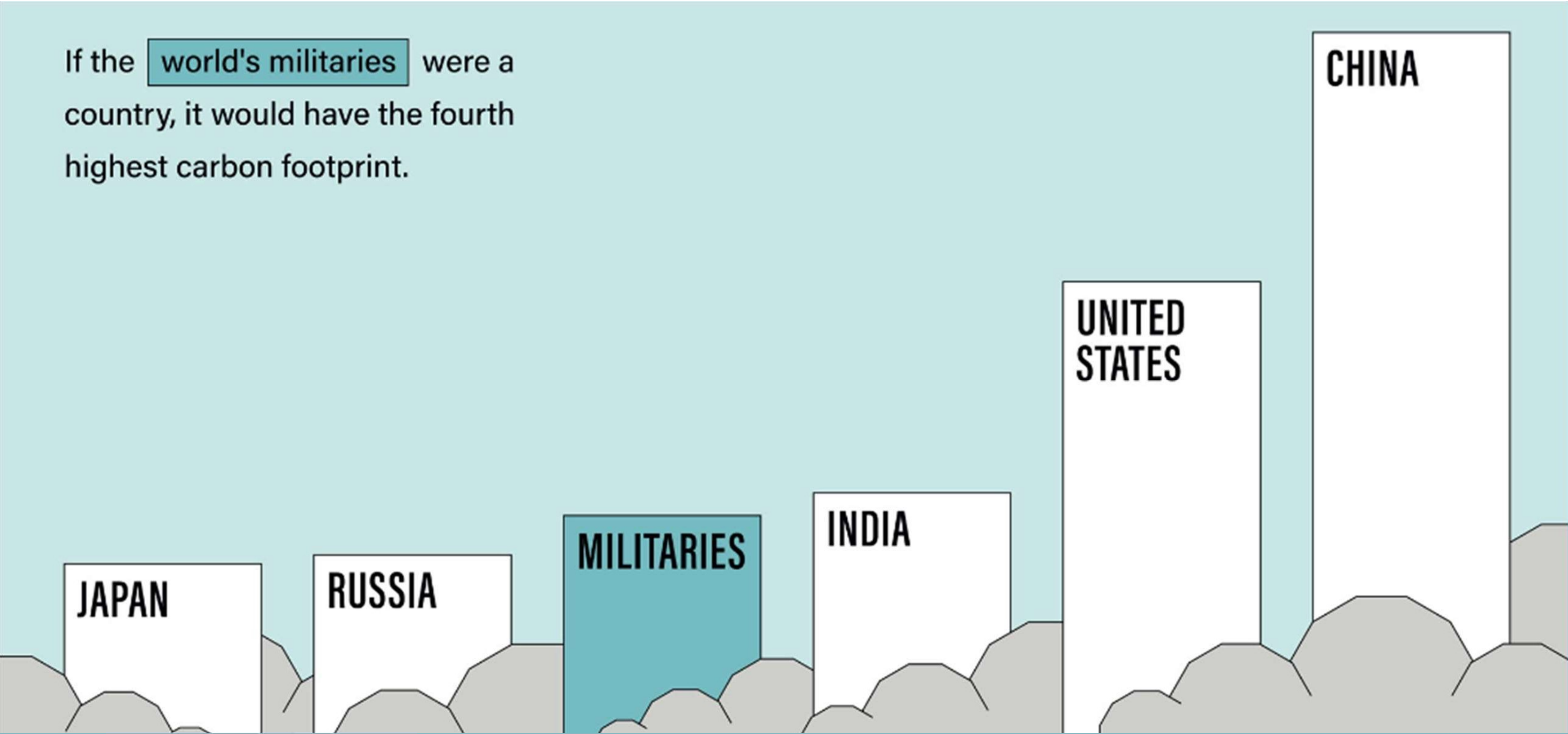
- Estimate – not based on UNFCCC data
- Used ‘active’ military personnel numbers & ‘stationary’ emission
- Ratio of ‘stationary’ to mobile emissions and supply chain multiplier
- **2,750** million tonnes CO_2, **5.5%** of global total



https://tinyurl.com/cxp2edw9

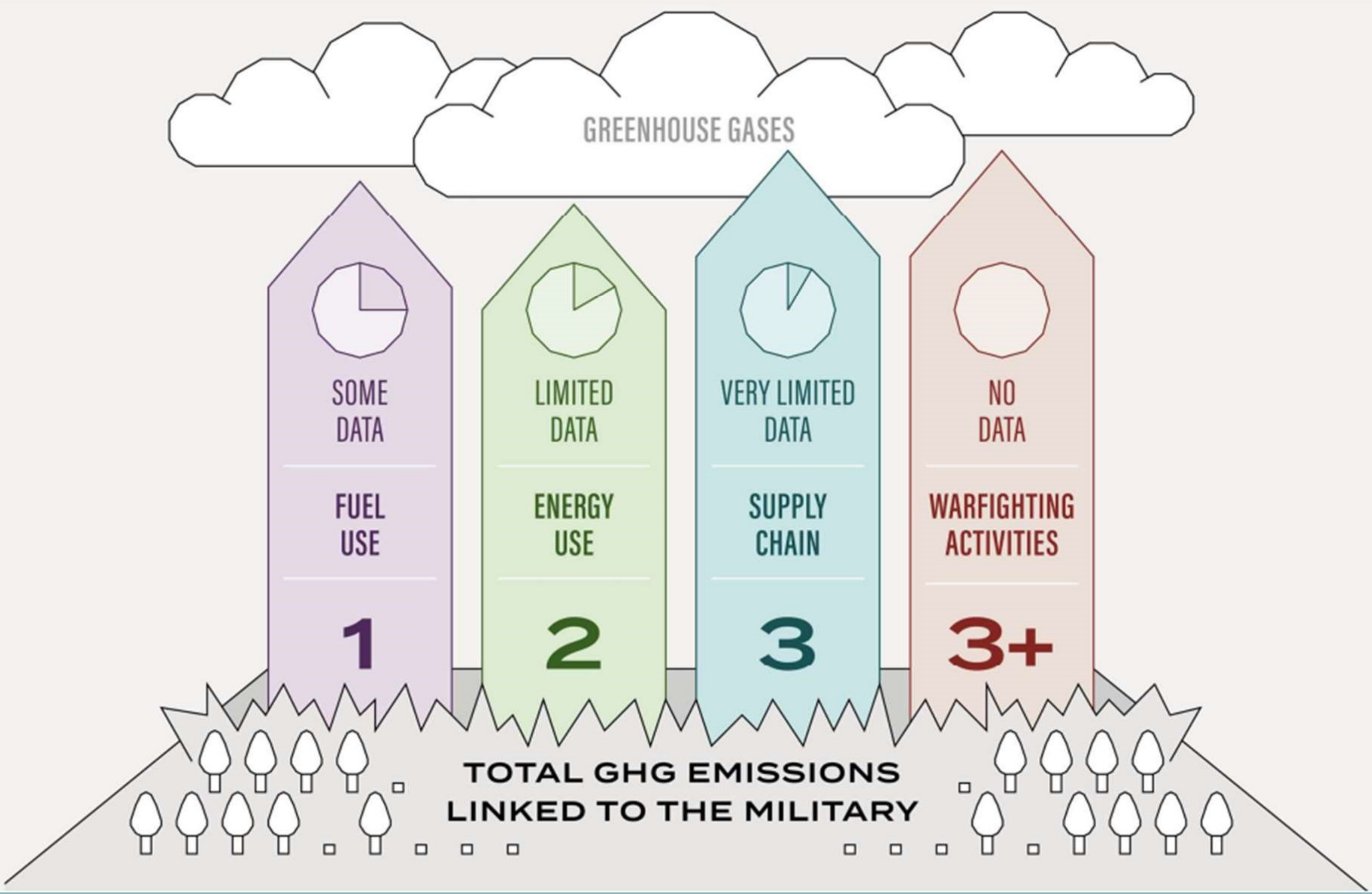
Conflict and Environment Observatory

The Minor Foundation for Major Challenges



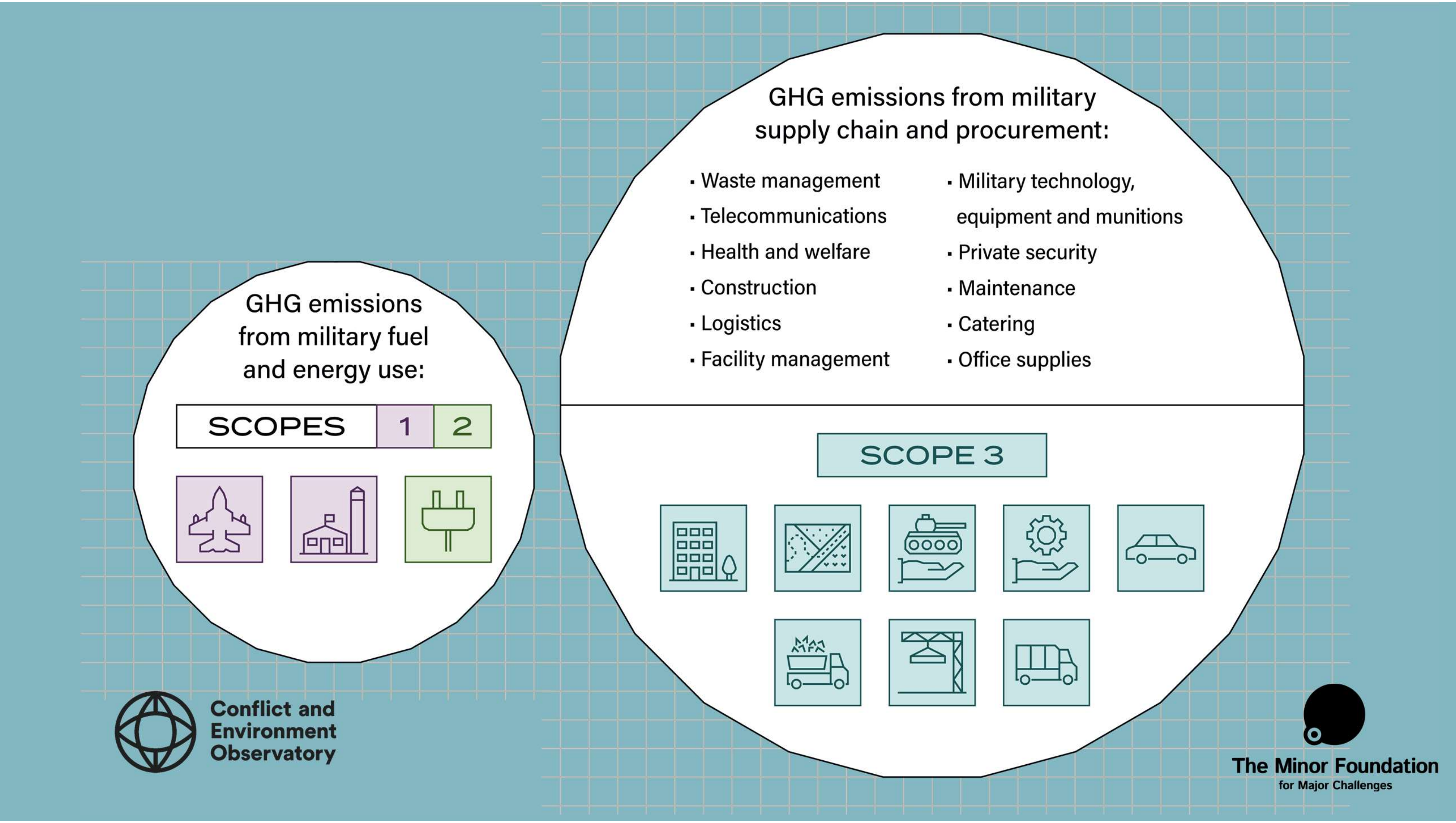
Conflict and Environment Observatory

The Minor Foundation for Major Challenges



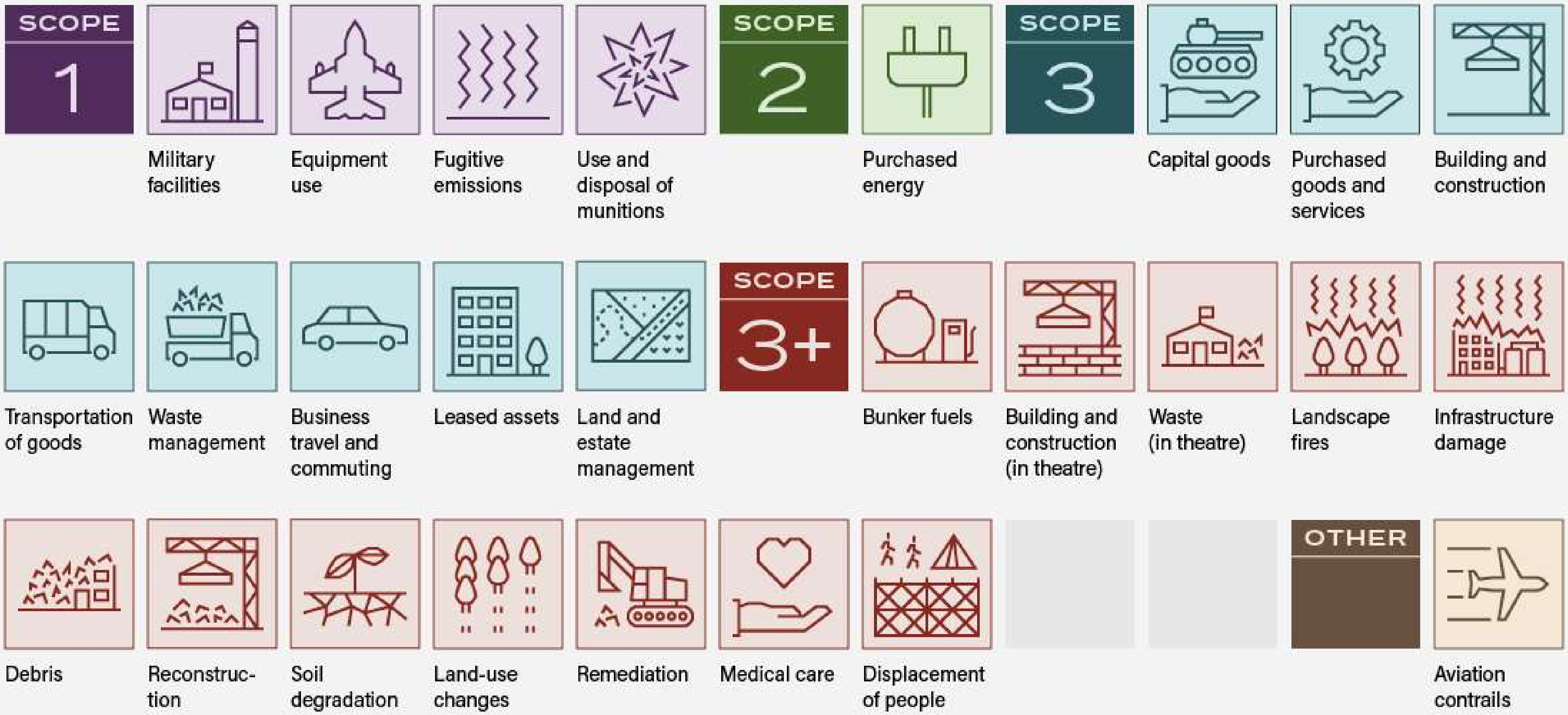
Conflict and Environment Observatory

The Minor Foundation for Major Challenges


GHG emissions from military fuel and energy use:
SCOPES 1 2
GHG emissions from military supply chain and procurement:
▪ Waste management
▪ Telecommunications
▪ Health and welfare
▪ Construction
▪ Logistics
▪ Facility management
▪ Military technology, equipment and munitions
▪ Private security
▪ Maintenance
▪ Catering
▪ Office supplies
SCOPE 3
Conflict and Environment Observatory
The Minor Foundation for Major Challenges

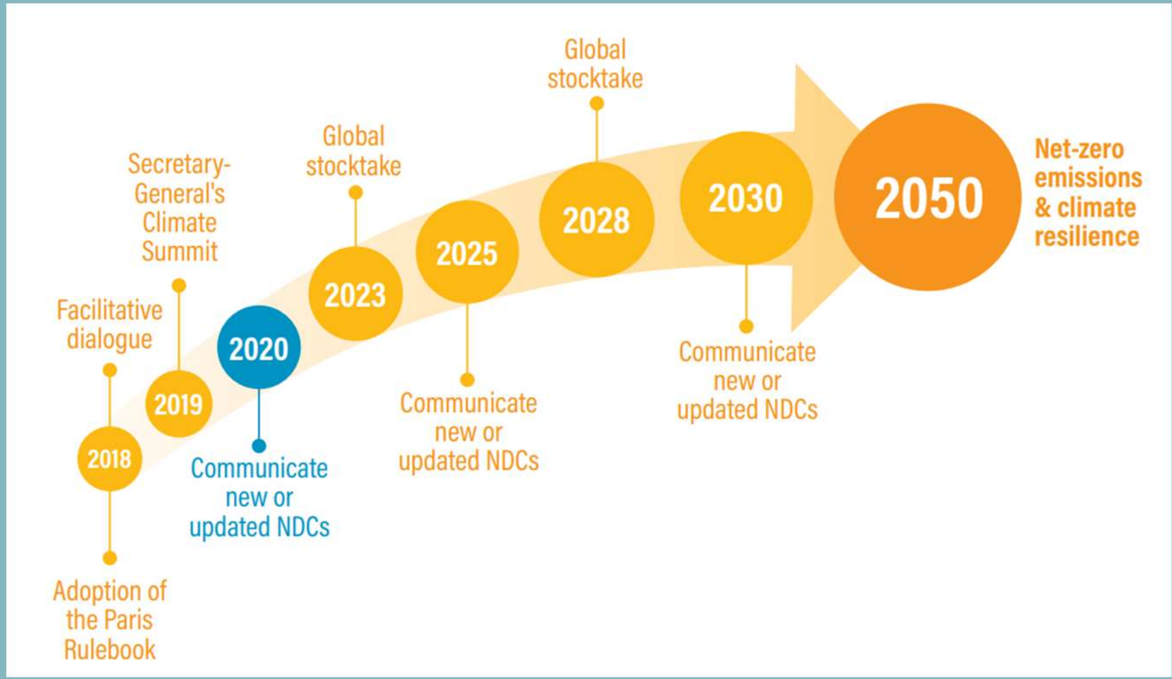
Proposed scopes of military greenhouse gas emissions

militaryemissions.org
@milemissionsgap



Nationally Determined Contributions (NDCs)

- National action plans
- Key to achieving long-term goals
- New NDCs from 2020, then updated every five years
- Successive NDCs need to be ambitious
- Military GHG reductions not in current NDCs



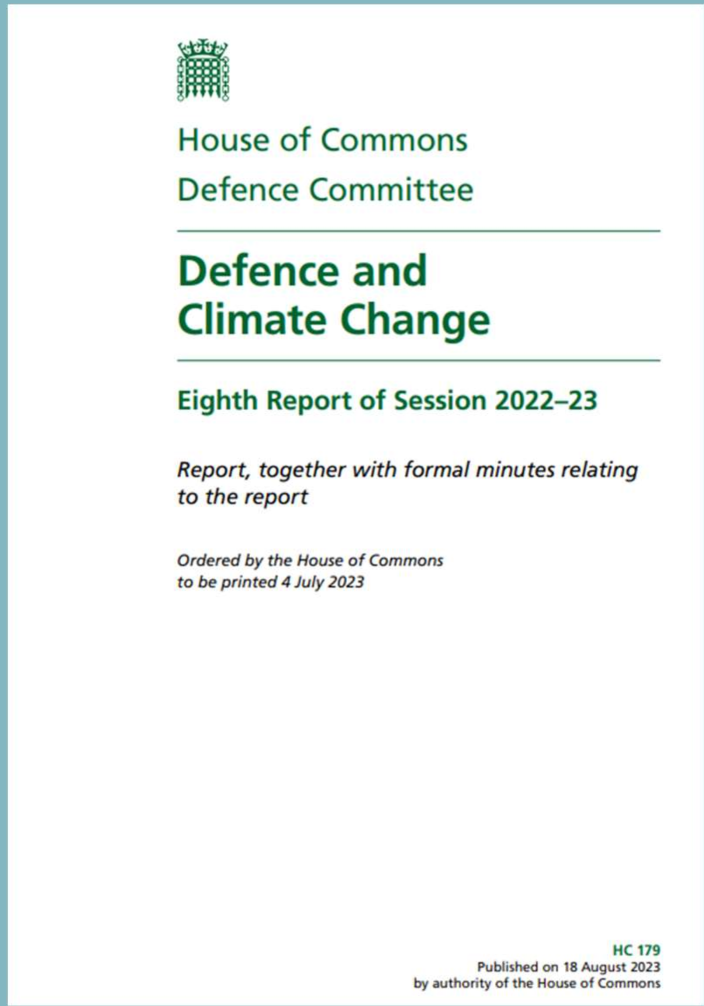
Source: https://www.wri.org/publication/ndc-enhancement-by-2020

Conflict and Environment Observatory

The Minor Foundation for Major Challenges

Importance of data and targets

- Better understanding of total emissions
- Separate reporting across the MOD’s top-level budget holders
- Setting of consistent milestones or targets


House of Commons
Defence Committee

Defence and Climate Change

Eighth Report of Session 2022–23

Report, together with formal minutes relating to the report

Ordered by the House of Commons to be printed 4 July 2023

HC 179
Published on 18 August 2023
by authority of the House of Commons

https://tinyurl.com/eyx6nmwk

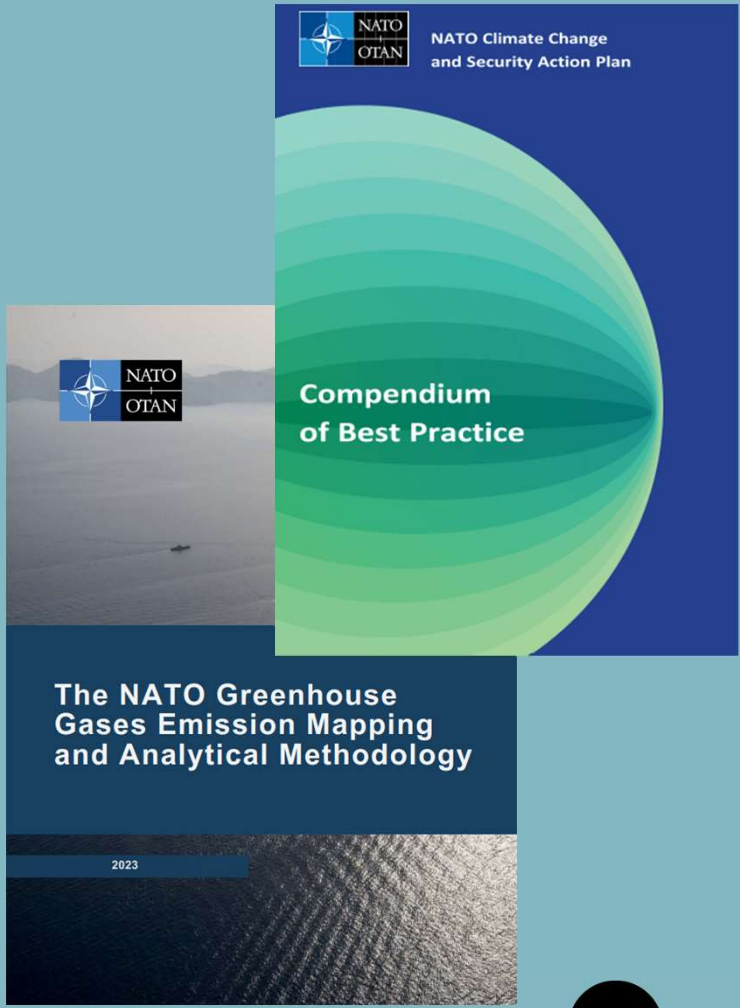
Conflict and Environment Observatory

The Minor Foundation for Major Challenges

https://tinyurl.com/2c6fs9ab

Steps already being taken

- Published NATO methodology:
  - explicitly excludes emissions from NATO-led operations and missions
- Compendium of best practice:
  - annual updates?
- Scope of in-country military emissions reporting:
  - Slovenia, Denmark, and Norway



https://tinyurl.com/4nmde3xe

Conflict and Environment Observatory

The Minor Foundation for Major Challenges

To conclude….

- Transparency and an improvement in reporting and data is critical
- Need emissions addressed under UNFCCC and in the NDCs
- Improvements possible – reflected already in some in-country reporting
- Reporting improvements needed
- Reduction commitments and target setting needed
- Be curious - check your government's reporting - www.militaryemissions.org
  - check your government's NDC - https://unfccc.int/NDCREG

Conflict and Environment Observatory

The Minor Foundation for Major Challenges

Thank you

Linsey Cottrell

Environmental Policy Officer - Conflict and Environment Observatory

www.militaryemissions.org

Conflict and Environment Observatory

The Minor Foundation for Major Challenges

Military Emissions Gap Conference 2023

MILITARY AND CONFLICT GHG EMISSIONS: FROM UNDERSTANDING TO MITIGATION

Tuesday 26 September, University of Oxford, and online

CONCRETE IMPACTS

Conflict and Environment Observatory

Scientists for Global Responsibility

UNIVERSITY OF OXFORD

Queen Mary University of London

The Minor Foundation

1 2 90 UNIVERSIDADE D COIMBRA

MILITARY EMISSIONS GAP CONFERENCE:
AN OVERVIEW OF THE MILITARY CARBON FOOTPRINT (PANEL 1)

ENVIRONMENT ASSESSMENT OF WEAPON SYSTEMS WITH A LIFE-CYCLE APPROACH

Carlos Ferreira
José Baranda Ribeiro

ADAI

26[TH] SEPTEMBER, OXFORD, UK

ADAI research group capabilities

Provide conditions for the formulation and experimental characterization of energetic materials and expertise in ammunition technology:

- Explosives

  Detonation velocity and pressure; Detonation front curvature; Critical diameter and detonation extinction phenomena; Features of the shock initiation of explosives; Features of crystal reaction kinetics.
- Propellants

  Combustion rates.
- Pyrotechnics

  Initiation devices.
- Ammunition expertise

  Long term collaboration with the Portuguese Armed Forces, NATO-STO AVT Technical groups, and demilitarization companies.

ADAI research group capabilities

Develops and applies tools to enhance the sustainability of products and systems supported by life-cycle thinking. The team provides expertise in:

- Life-cycle management;
- Environmental life-cycle assessment (LCA);
- Life-Cycle Costing (LCC);
- Ecodesign;
- Urban metabolism;
- Circular Economy;
- Other sustainability tools.

Participation in NATO-STO AVT research groups and EDA projects

Main NATO-AVT activities:

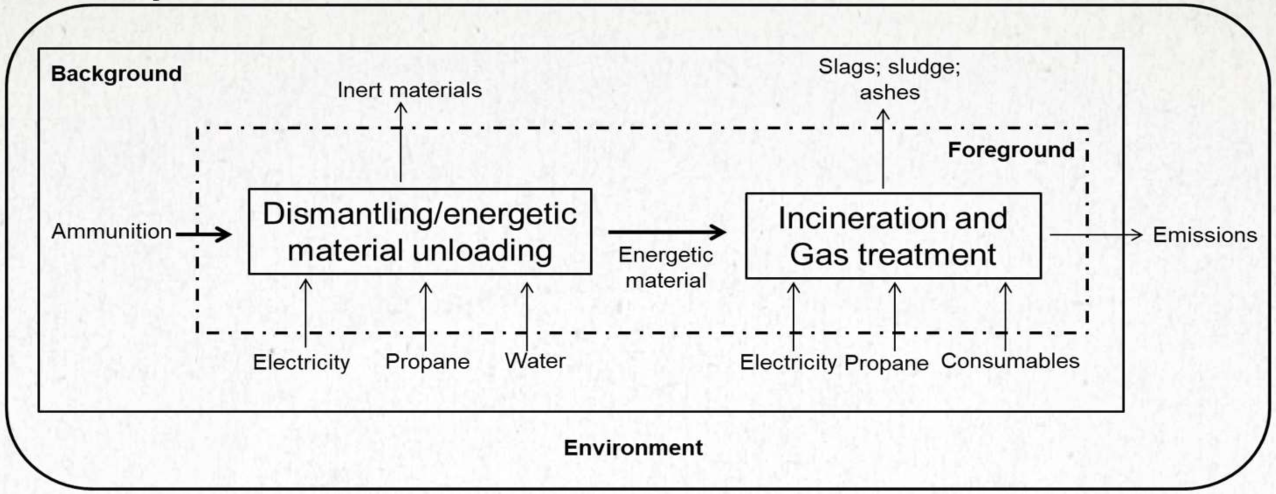
- AVT-177 – Munition and propellant disposal and its impact on the environment
- AVT-179 – Design for disposal of present and future munitions and application of greener munition technology
- AVT-277 – Hazard assessment of exposure to ammunition-related constituents and combustion products
- AVT-293 – Effect of environmental regulation on energetic systems and the management of critical munitions materials and capability

EDA Projects:

- ERM – Environmental responsible munitions (2011-2015);
- PREMIUM - Prediction models for implementation of munition health management (2021- 2025)

LCA application for military systems

Demilitarization of military ammunition with incineration in a static kiln



Source: Ferreira, C., Ribeiro, B., Mendes, R., Freire, F. (2013). “Life-Cycle Assessment of ammunition demilitarisation in a static kiln”. Propellants, Explosives, Pyrotechnics, 2013, 38, 296 – 302.

LCA application for military systems

Demilitarization of military ammunition

- Primary data was used from the demilitarization company

Inventory for dismantling and discharging (per kg TNT eq.)

Inputs	Energy	
	Electricity	1.369 kWh
	Propane	0.479 kg
	Materials	
	Water	6.161 kg

Inventory for incineration and gas treatment (per kg TNT eq.)

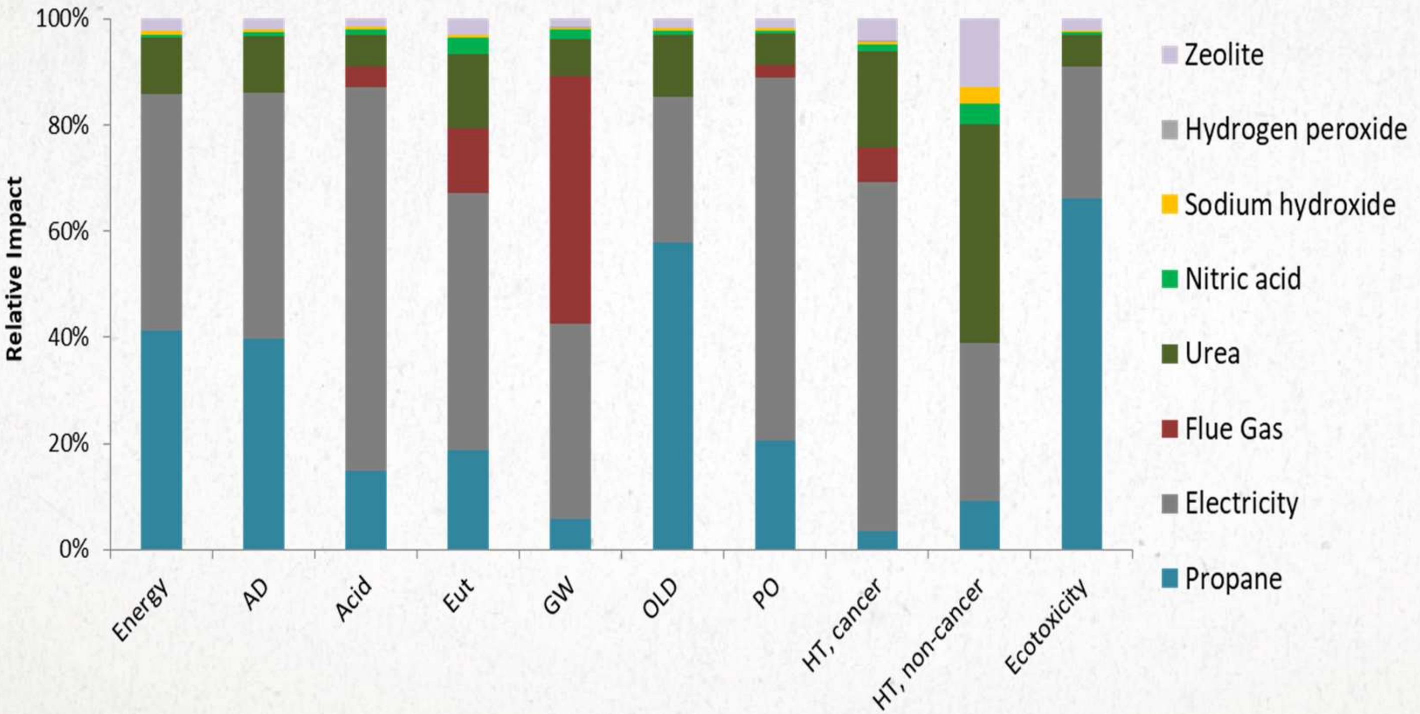
Incineration and gas treatment				
Inputs	Energy			
	Electricity			7.860 kWh
	Propane			1.320 kg
	Materials			
	Water			15.31 kg
	Urea			0.280 kg
	Hydrochloric acid			0.078 kg
	Sodium hydroxide			0.060 kg
	Hydrogen peroxide			0.004 kg
	Zeolite			0.050 kg
Outputs	Materials			
	Sludge			0.008 kg
	Fly ashes			0.032 kg
	Ash and slag			0.040 kg
	Emissions to air[a)]			
	2,3,7,8TCDD*	8.65E−13 kg	NO_x	4.06E−03 kg
	1,2,3,4,7,8HxCDD*	1.73E−12 kg	SO_2	3.98E−04 kg
	1,2,3,7,8,9HxCDD*	8.65E−13 kg	Hg	1.71E−06 kg
	1,2,3,4,6,7,8HpCDD*	8.65E−13 kg	Cd	1.54E−06 kg
	OCDD*	8.65E−15 kg	As	3.33E−06 kg
	Furan	9.52E−12 kg	Ni	2.47E−06 kg
	HF	8.36E−05 kg	Pb	2.05E−06 kg
	HCl	8.36E−05 kg	Cu	2.05E−06 kg
	VOC	6.55E−04 kg	Cr	2.05E−06 kg
	CO	1.28E−03 kg	CO_2	6.24E+00 kg
	H_2S	2.81E−04 kg	PM	4.20E−04 kg

Source: Ferreira, C., Ribeiro, B., Mendes, R., Freire, F. (2013). "Life-Cycle Assessment of ammunition demilitarisation in a static kiln". Propellants, Explosives, Pyrotechnics, 2013, 38, 296 – 302.

LCA application for military systems

Demilitarization of military ammunition

- Impacts associated with the incineration in a static kiln and flue gas treatment processes.



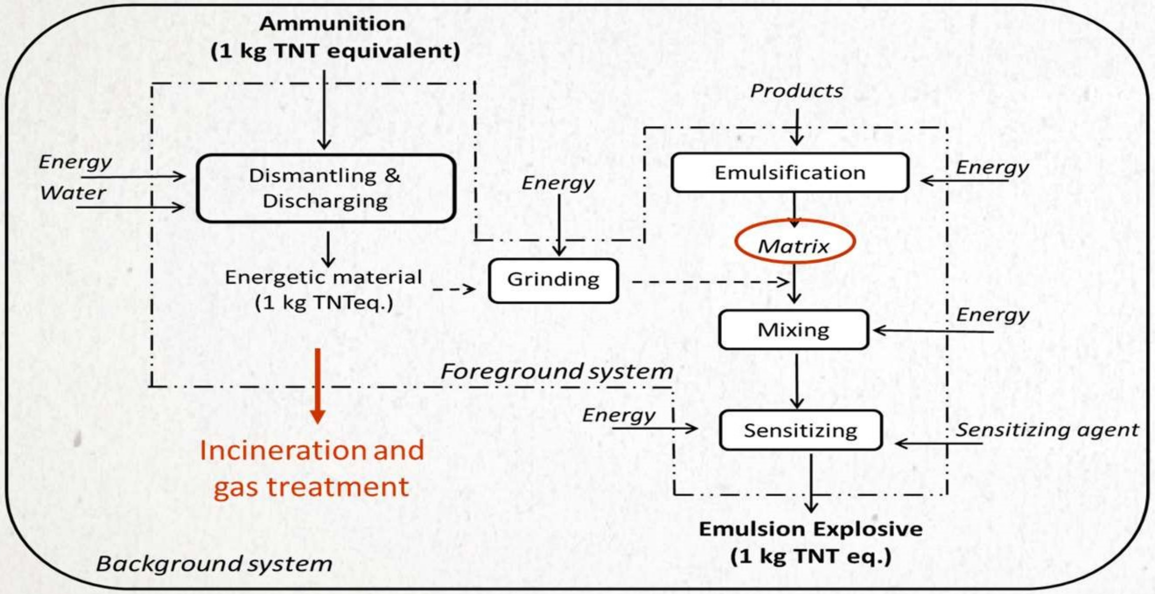
Source: Ferreira, C., Ribeiro, B., Mendes, R., Freire, F. (2013). "Life-Cycle Assessment of ammunition demilitarisation in a static kiln". Propellants, Explosives, Pyrotechnics, 2013, 38, 296 – 302.

LCA application for military systems

Downcycling of energetic material from military ammunition via incorporation into civil explosives

A circular economy approach

Energetic material valorization process



Primary data provided from a company that produces civil explosives

Table 1
Mass balance Inventory for the emulsion explosive production (per kg TNTeq).

Constituents	Amount
Inputs	
Ammonium Nitrate	1.06 kg
Water	0.16 kg
XPS	0.03 kg
Mineral oil	0.13 kg
Polycarboxylate	0.07 kg
Packing	
Polyethylene	0.05 kg
Outputs	
Emulsion explosive (includes packing)	1.50 kg
Ashes	0.002 kg
Inert material	0.003 kg

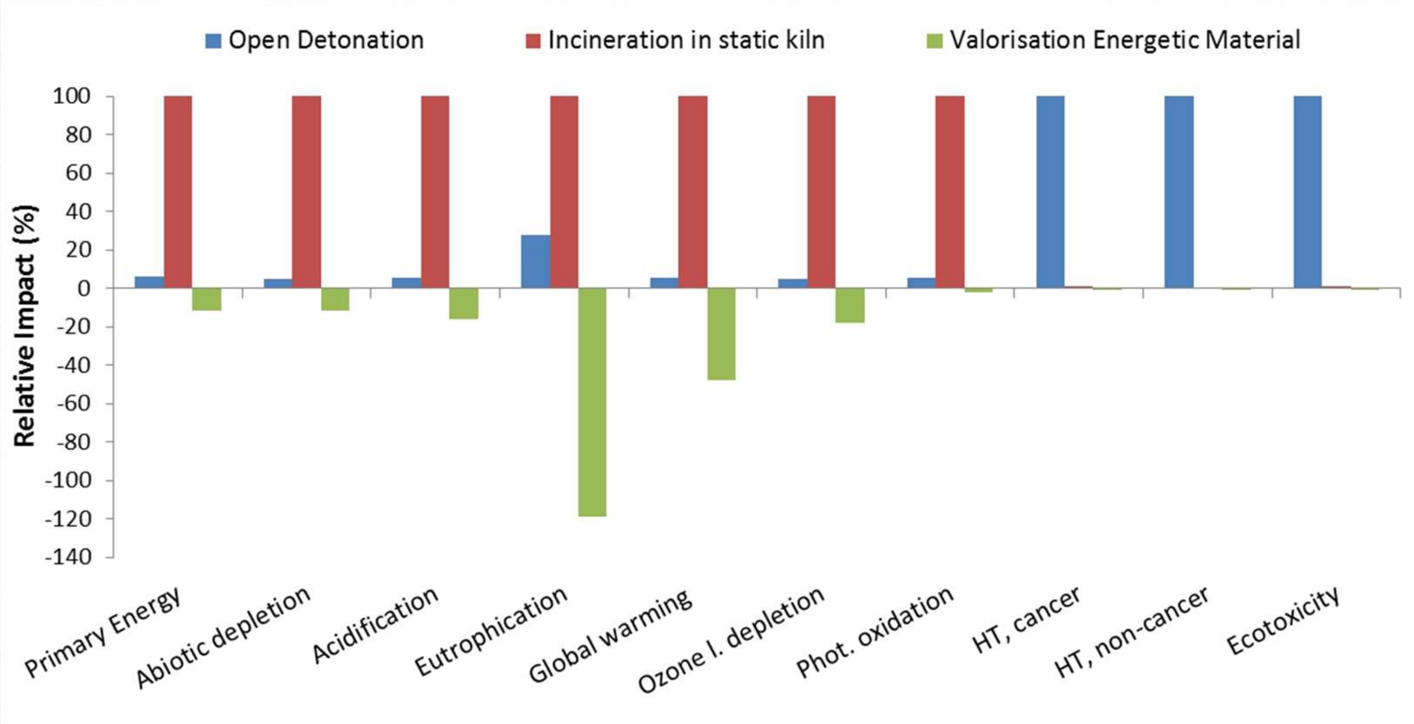
Table 2
Energy requirement of the emulsion explosive production (per kg TNTeq).

Energy requirement	Amount
Electricity	0.11 kWh
Naphtha	0.01 kg

Source: C. Ferreira, F. Freire, J. Ribeiro, Life-cycle assessment of a civil explosive, Journal of Cleaner Production, 89, 2015, 159 – 164.

LCA application for military systems

Comparison between three methods of ammunition disposal: open detonation, incineration in a static kiln, recycling of energetic material.



Source: C. Ferreira, F. Freire, J. Ribeiro, Life-cycle assessment of a civil explosive, Journal of Cleaner Production, 89, 2015, 159 – 164.

LCA application for military systems

The next step was to assess the impacts from the other life-cycle phases of ammunition (production and use)

The main motivation to carry out this studies:

- Large amount of munitions used in training – contamination of military ranges
- Production have a significant impact that needs to be considered (e.g. carbon footprint)
- Impacts over human health – (e.g. inhalation of fumes from soldiers)

Collaboration in EDA project and NATO groups allowed to obtain information in order to assess the impacts of large and small calibers.

LCA application for military systems

Creation of databases:

- The creation of the life-cycle inventory is one of the most important steps of the LCA studies - Compilation of data regarding energy, materials, products, transport, co-products, etc.

- EcoInvent has a set of databases available for different types of raw materials, chemicals, energy sources, etc. However, energetic materials and other chemicals are missing in those databases.

- Experience in creating databases for different types of materials, products and activities:

Hierarchy of data compilation

Real data
surveys for compilation of data from industry

Literature data

Estimations following recommendations from EcoInvent

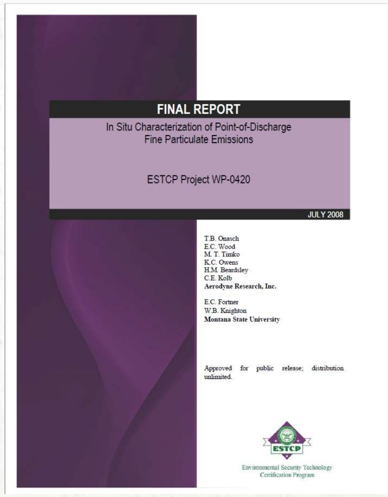
LCA application for military systems

Creation of databases:

- The inventories created are based on a complementary combination of the three approaches based on the type of data that is available.

- The real data obtained from the industry for the energetic material production is very scarce.

- Most of the data used in the compilation of information is based on literature sources, such as scientific papers, books, patents, sustainability reports, or companies' websites.


FINAL REPORT

In Situ Characterization of Point-of-Discharge Fine Particulate Emissions

ESTCP Project WP-0420

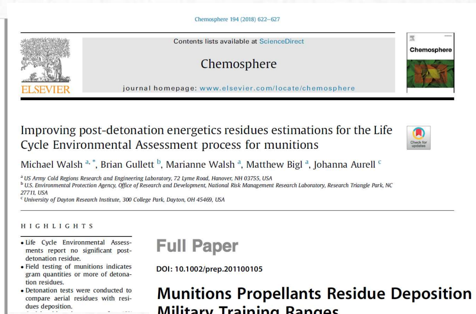
JULY 2008

T.B. Onasch
E.C. Wood
M. T. Timko
K.C. Owens
H.M. Beardsley
C.E. Kolb
Aerodyne Research, Inc.

E.C. Fortner
W.B. Knighton
Montana State University

Approved for public release; distribution unlimited.

Environmental Security Technology Certification Program


Chemosphere 194 (2018) 622–627

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

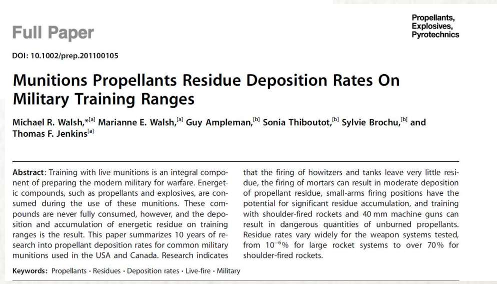
Improving post-detonation energetics residues estimations for the Life Cycle Environmental Assessment process for munitions

Michael Walsh [a,*], Brian Gullett [b], Marianne Walsh [a], Matthew Bigl [a], Johanna Aurell [c]

[a] US Army Cold Regions Research and Engineering Laboratory, 72 Lyme Road, Hanover, NH 03755, USA
[b] U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Research Triangle Park, NC 27711, USA
[c] University of Dayton Research Institute, 300 College Park, Dayton, OH 45469, USA

HIGHLIGHTS

- Life Cycle Environmental Assessments report no significant post-detonation residue.
- Field testing of munitions indicates gram quantities or more of detonation residues.
- Detonation tests were conducted to compare aerial residues with residues deposition.


Full Paper

Propellants, Explosives, Pyrotechnics

DOI: 10.1002/prep.201100105

Munitions Propellants Residue Deposition Rates On Military Training Ranges

Michael R. Walsh,*[a] Marianne E. Walsh,[a] Guy Ampleman,[b] Sonia Thiboutot,[b] Sylvie Brochu,[b] and Thomas F. Jenkins[a]

Abstract: Training with live munitions is an integral component of preparing the modern military for warfare. Energetic compounds, such as propellants and explosives, are consumed during the use of these munitions. These compounds are never fully consumed, however, and the deposition and accumulation of energetic residue on training ranges is the result. This paper summarizes 10 years of research into propellant deposition rates for common military munitions used in the USA and Canada. Research indicates that the firing of howitzers and tanks leave very little residue, the firing of mortars can result in moderate deposition of propellant residue, small-arms firing positions have the potential for significant residue accumulation, and training with shoulder-fired rockets and 40 mm machine guns can result in dangerous quantities of unburned propellants. Residue rates vary widely for the weapon systems tested, from 10^{-6}% for large rocket systems to over 70% for shoulder-fired rockets.

Keywords: Propellants · Residues · Deposition rates · Live-fire · Military

LCA application for military systems

Creation of databases:

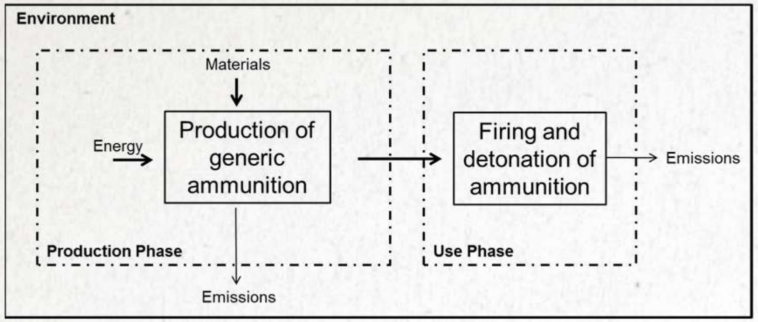
Third approach: life-cycle inventories for production are created based on the procedure developed by Hischier *et al.* (2005), as implemented in other LCA studies.

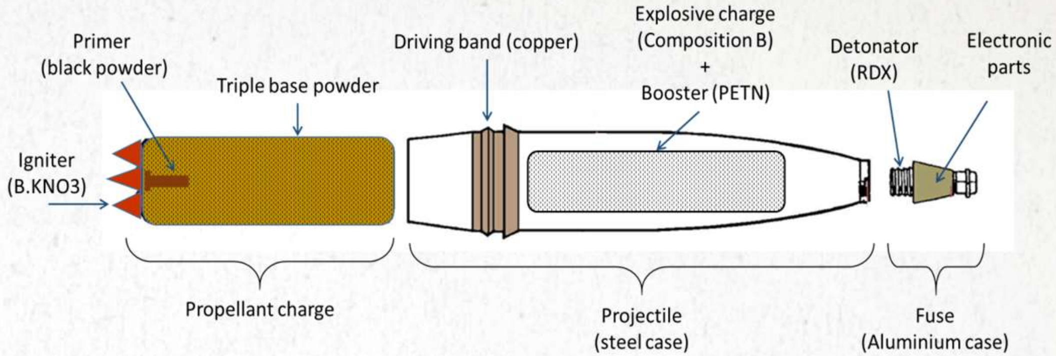
This approach suggests:

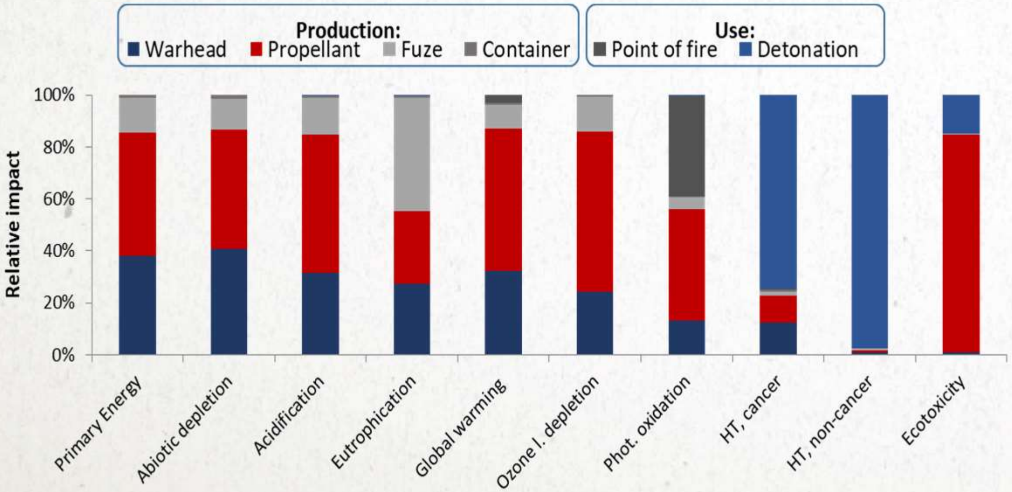
- Stoichiometric chemical equation to account for raw materials consumption (with an efficiency level of 95 %);
- Consumption of electricity and heat based on average values (0.33 kWh and 2 MJ per kg of product - Gendorf, 2000);
- 0.2 % of the volatile input materials are emitted into the air.

LCA application for military systems

AVT study – production and use of large caliber (155 mm caliber ammunition)



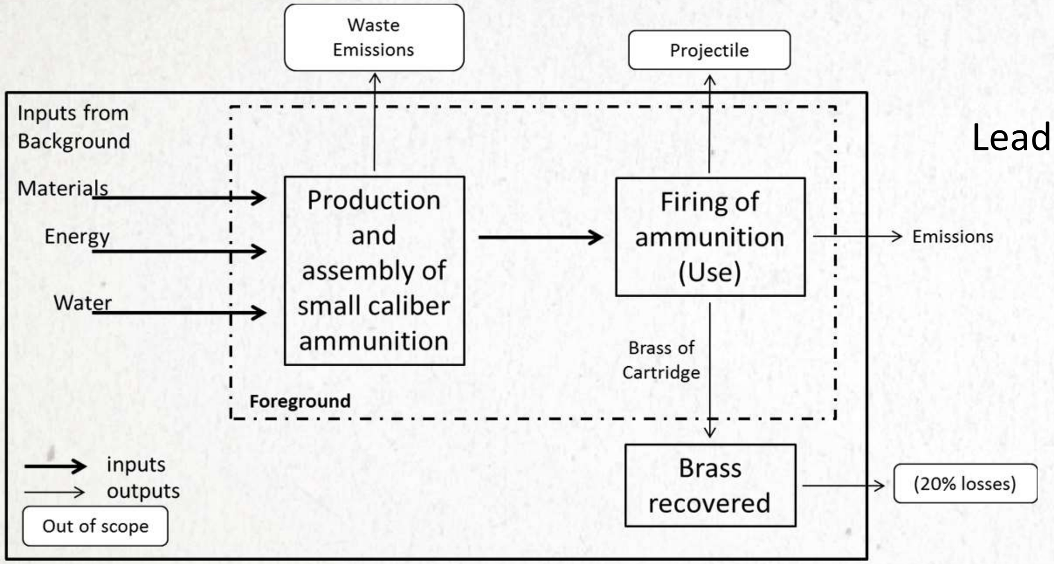




- Production presents a higher contribution to the environment impact categories;
- Use phase has a higher contribution to the toxicological impact categories;
- Exception for triple base powder production for ecotoxicity: emissions of insecticides into the soil (Profenofos, Cyfluthrin, Chlorpyrifos, and Aldicarb) used in the cultivation of cotton - nitrocellulose production.

LCA application for military systems

EDA project - Ecodesign of small calibre ammunition



4 different small caliber munition:

- Steel-lead projectile
  - Lead primer #1
  - Non-lead primer #2
- Composite projectile
  - Lead primer #3
  - Non-lead primer #4

Ferreira C, Ribeiro J, Almada S, Rotariu T, Freire F (2016) Reducing impacts from ammunitions: A comparative life-cycle assessment of four types of 9 mm ammunitions, *Science of The Total Environment* 566-567, 1: 34 - 40

LCA application for military systems

EDA project - Ecodesign of small calibre ammunition

4 different small caliber munition:

Primary data regarding the main components of the ammunition and the emissions

	#1		#2		#3		#4	
	Constitution	Amount (kg)	Constitution	Amount (kg)	Constitution	Amount (kg)	Constitution	Amount (kg)
Cartridge	Brass	4.9E−03	Brass	4.9E−03	Brass	4.9E−03	Brass	4.9E−03
Projectile	Steel	3.9E−03	Steel	3.9E−03	Nylon	4.1E−03	Nylon	4.1E−03
	Lead	6.1E−03	Lead	6.1E−03	Copper	1.0E−03	Copper	1.0E−03
	Antimony powder	9.5E−05	Antimony powder	9.5E−05				
Primer	Brass	2.4E−04	Brass	2.4E−04	Brass	2.4E−04	Brass	2.4E−04
	TNR-Pb	1.0E−05	DDNP	6.3E−06	TNR-Pb	1.0E−05	DDNP	6.3E−06
	Tetrazene	1.3E−06	Tetrazene	1.3E−06	Tetrazene	1.3E−06	Tetrazene	1.3E−06
	Barium nitrate	4.9E−06			Barium nitrate	4.9E−06		
	Antimony sulphide	1.3E−06	Zinc peroxide	1.4E−05	Antimony sulphide	1.3E−06	Zinc peroxide	1.4E−05
	Lead dioxide	1.3E−06	Titanium powder	3.7E−06	Lead dioxide	1.3E−06	Titanium powder	3.7E−06
	Calcium silicide	1.3E−06			Calcium silicide	1.3E−06		
Propellant	Single base powder	4.1E−04	Single base powder	4.1E−04	Single base powder	4.1E−04	Single base powder	4.1E−04
	Cardboard	3.2E−04	Cardboard	3.2E−04	Cardboard	3.2E−04	Cardboard	3.2E−04
Total weight		**1.6E−02**		**1.6E−02**		**1.1E−02**		**1.1E−02**

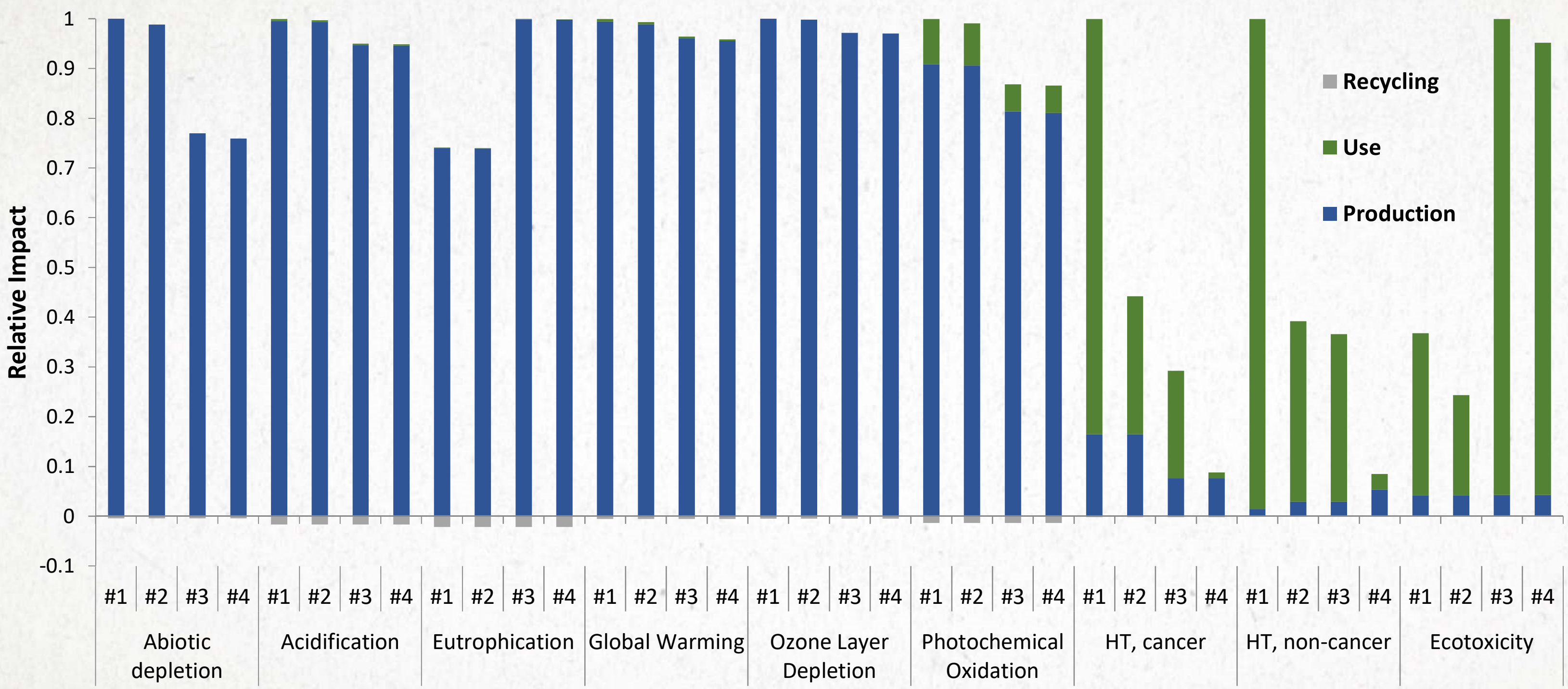
Substance	Emissions (mg/bullet)			
	#1	#2	#3	#4
CO	**198.65**	**184.75**	119.21	118.76
CO_2	**101.79**	**96.79**	58.56	57.93
NO	3.80	3.22	3.85	**4.41**
NO_2	**0.64**	**0.62**	0.49	0.52
NH_3	**3.10**	**2.46**	1.67	1.84
HCN	**1.77**	**1.22**	0.18	0.13
CH_4	**1.10**	**0.96**	0.61	0.59
Pb	**3.14**	**1.04**	0.81	0.04
Cu	0.55	0.41	**4.85**	**5.21**
Zn	**0.12**	**0.11**	**0.19**	0.03
Sb	**0.37**	**0.20**	0.15	ND

Electricity	0.046 kWh/bullet
Natural gas	0.240 MJ/bullet
Water	2.042 kg/bullet

Ferreira C, Ribeiro J, Almada S, Rotariu T, Freire F (2016) Reducing impacts from ammunitions: A comparative life-cycle assessment of four types of 9 mm ammunitions, *Science of The Total Environment* 566-567, 1: 34 - 40

LCA application for military systems

EDA project - Ecodesign of small calibre ammunition

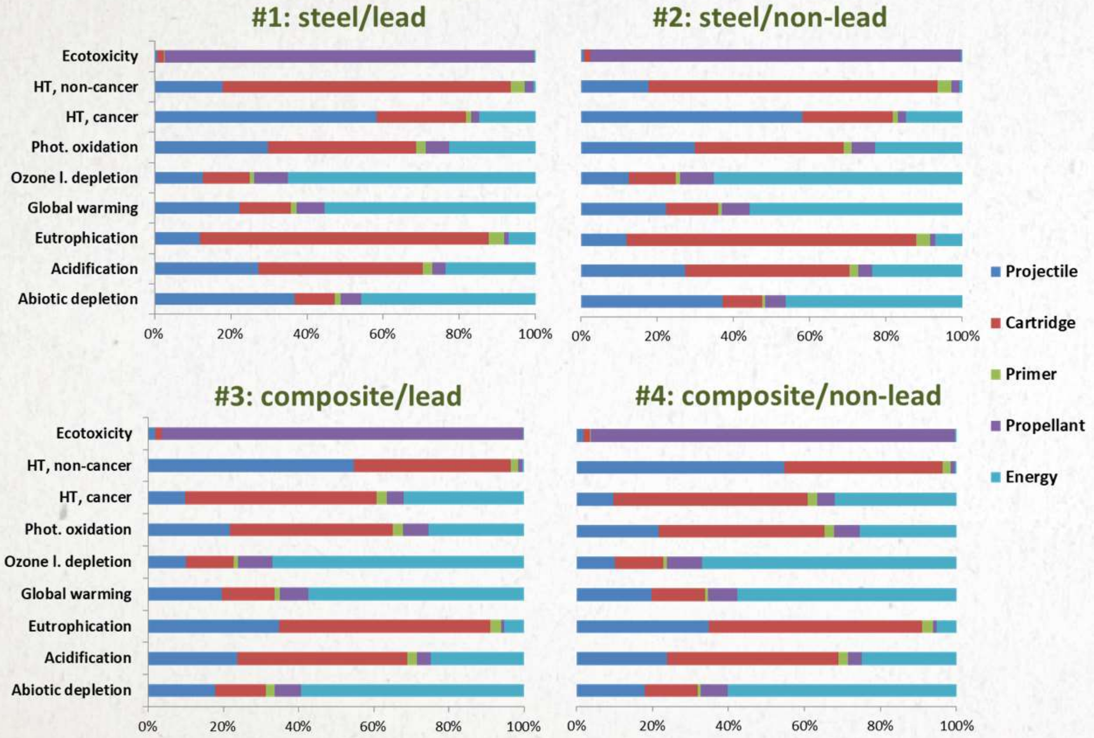


Ferreira C, Ribeiro J, Almada S, Rotariu T, Freire F (2016) Reducing impacts from ammunitions: A comparative life-cycle assessment of four types of 9 mm ammunitions, *Science of The Total Environment* 566-567, 1: 34 - 40

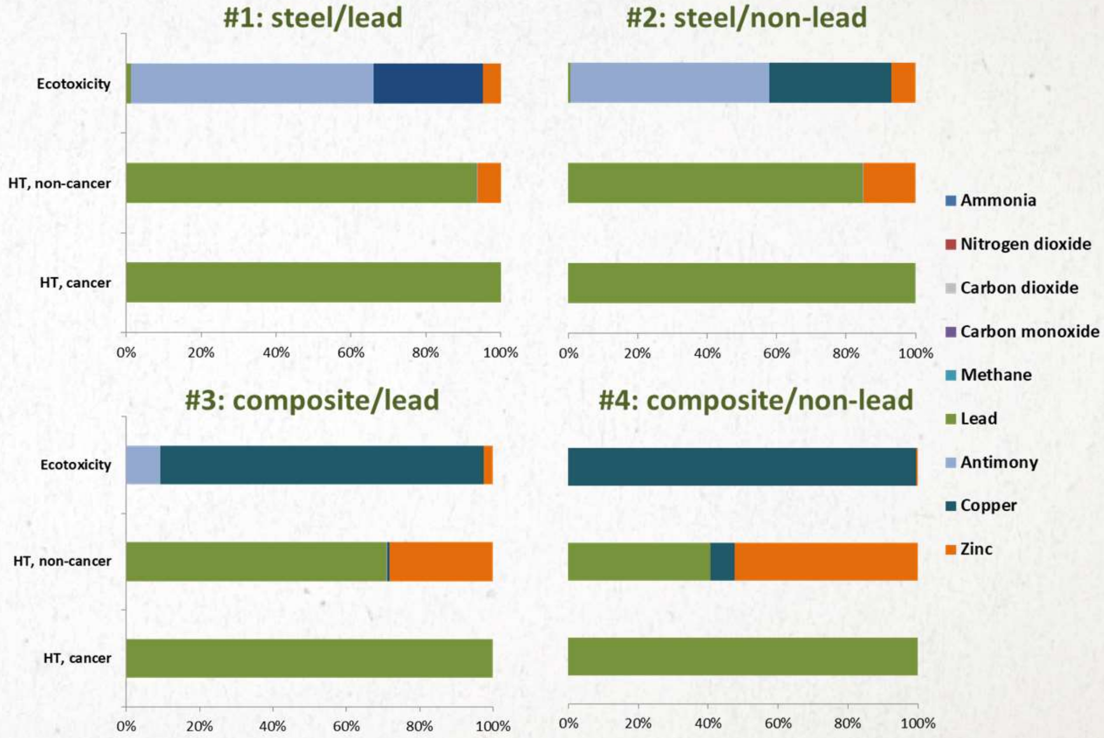
LCA application for military systems

EDA project - Ecodesign of small calibre ammunition

Production Phase



Use Phase



Ferreira C, Ribeiro J, Almada S, Rotariu T, Freire F (2016) Reducing impacts from ammunitions: A comparative life-cycle assessment of four types of 9 mm ammunitions, *Science of The Total Environment* 566-567, 1: 34 - 40

Conclusions

Contribution in the last 12 years for the improvement of the environment profile of military systems:

- Creation of inventories (production, use) for 20 energetic materials;
- Ecodesign of ammunition and their components (energetic and non-energetic);
- Identification of environmental hot-spots associated to ammunition;
- Development of greener "designed for disposal" ammunitions;
- Comparison of disposal techniques;
- Assessment of the degree of contamination of shooting ranges;
- Assessment of impacts over human health (in combination with REACH regulation).

Conclusions

Ongoing work:

- Assessment of indoor impacts;
- Development of a tool to assist the environment management of shooting ranges;
- Creation of a database for energetic materials (production and use) and weapon systems.

In the scope of AVT-SP-004 (NATO) and Incubation Forum from EDA.

UNIVERSIDADE Ð COIMBRA

1 2 9 0

THANK YOU!

Carlos Ferreira: carlos.ferreira@dem.uc.pt
José Baranda Ribeiro: jose.baranda@dem.uc.pt

Military Emissions Gap Conference 2023

MILITARY AND CONFLICT GHG EMISSIONS: FROM UNDERSTANDING TO MITIGATION

Tuesday 26 September, University of Oxford, and online

CONCRETE IMPACTS
Conflict and Environment Observatory
Scientists for Global Responsibility
UNIVERSITY OF OXFORD
Queen Mary University of London
The Minor Foundation

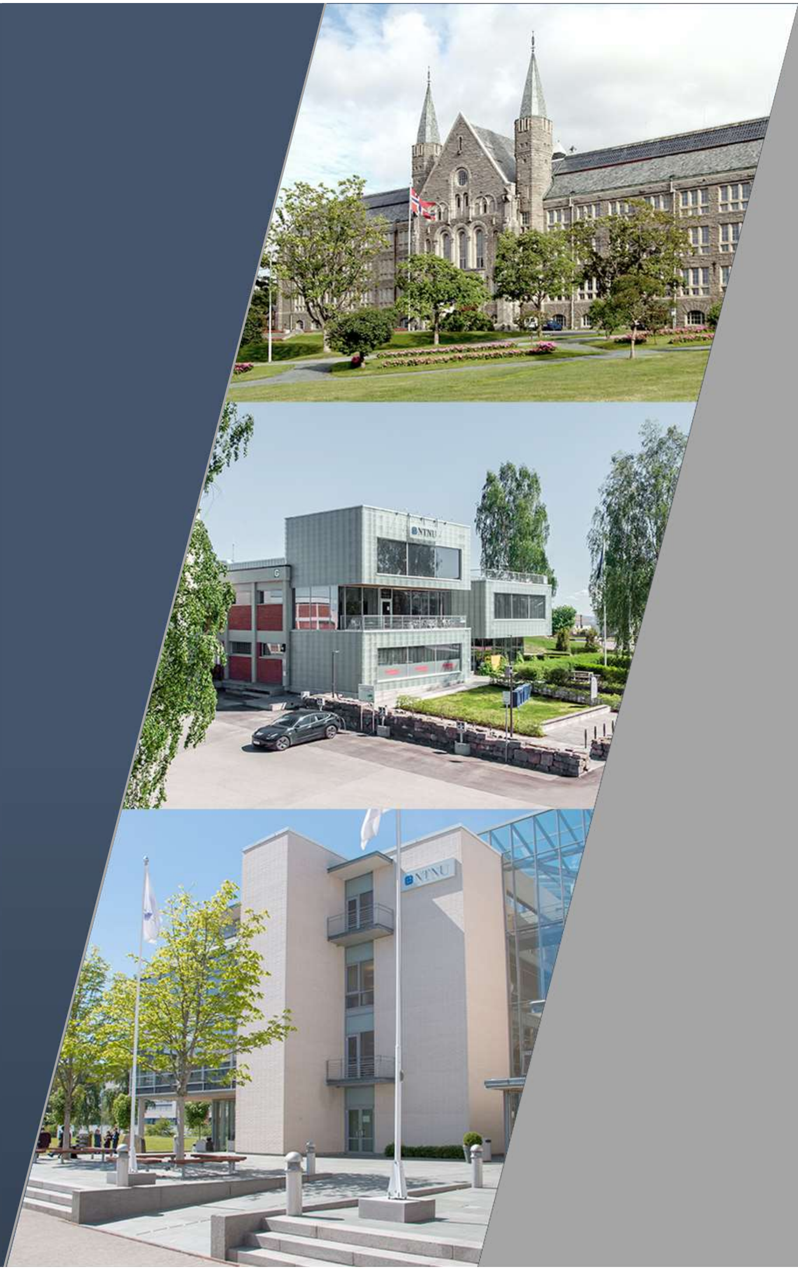
NTNU

Knowledge for a better world

Life cycle GHG emissions in the Norwegian defence sector

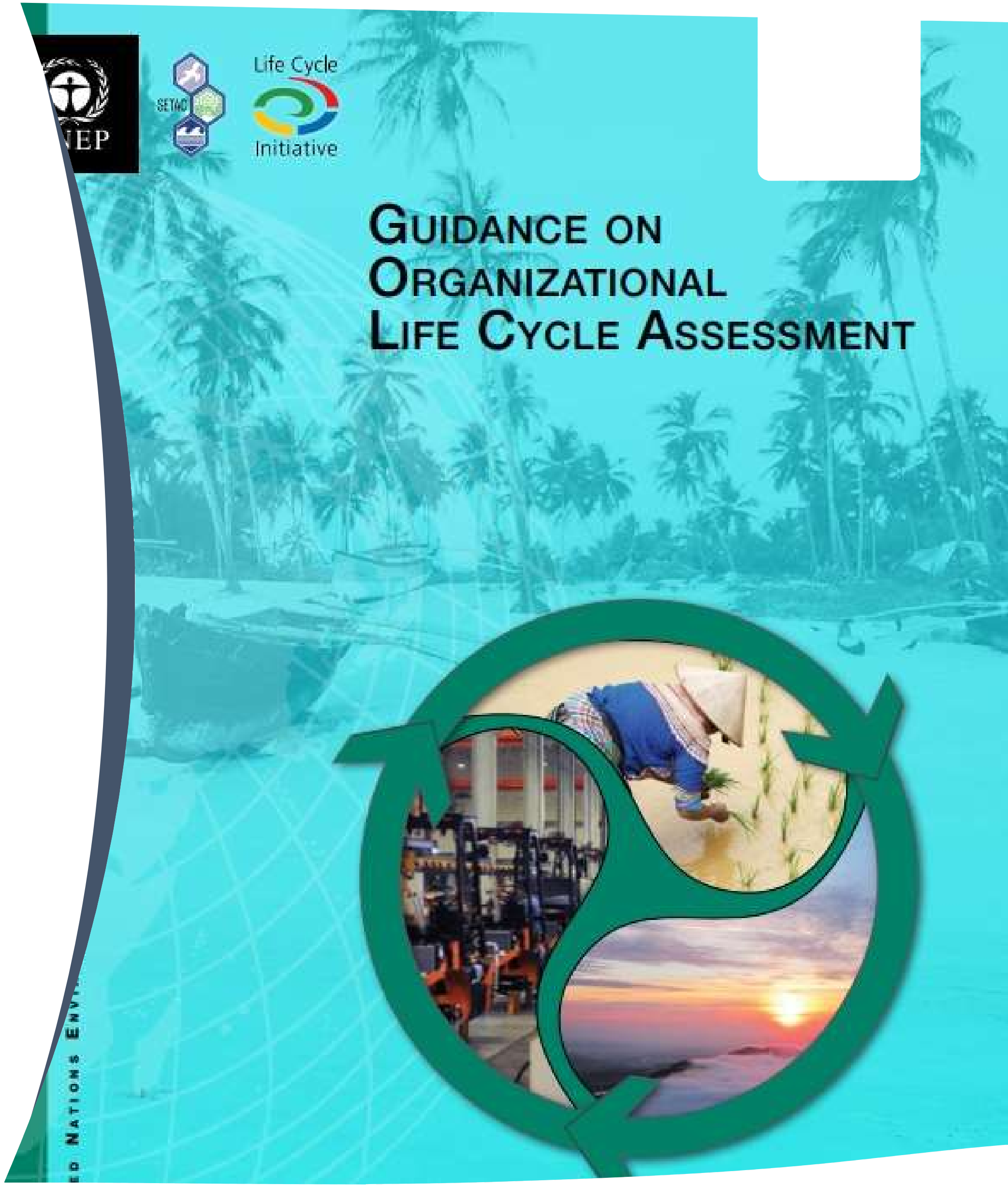
Magnus Sparrevik
Senior advisor Norwegian Defence Estates Agency

Adjunct professor NTNU



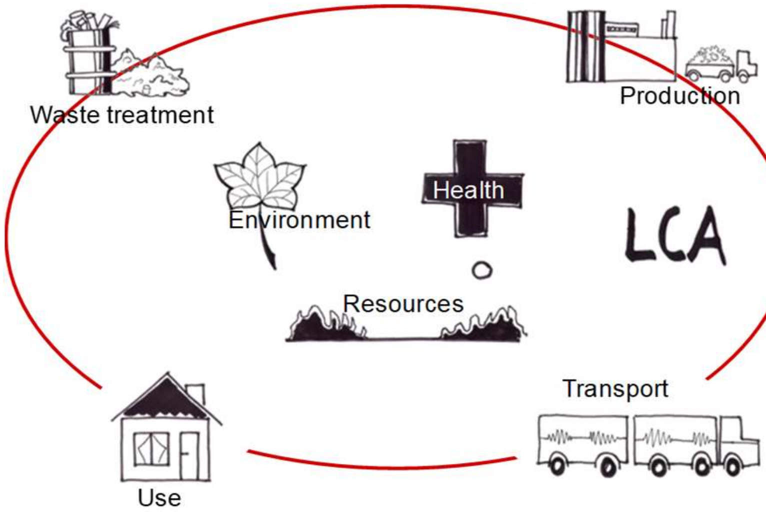
History

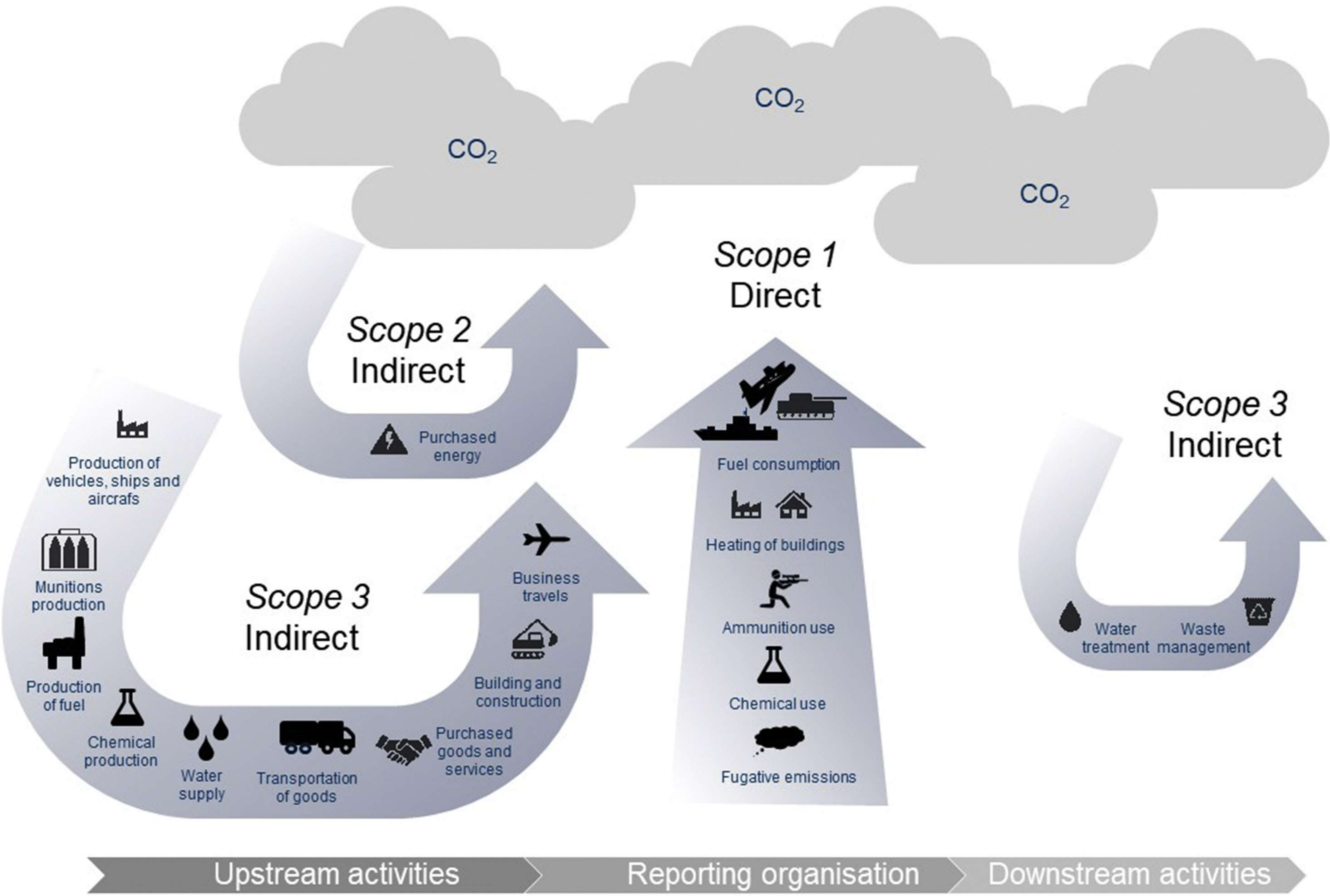
Master thesis in 2017 - inspired of the SETAC UNEP Framework of organizational LCA.



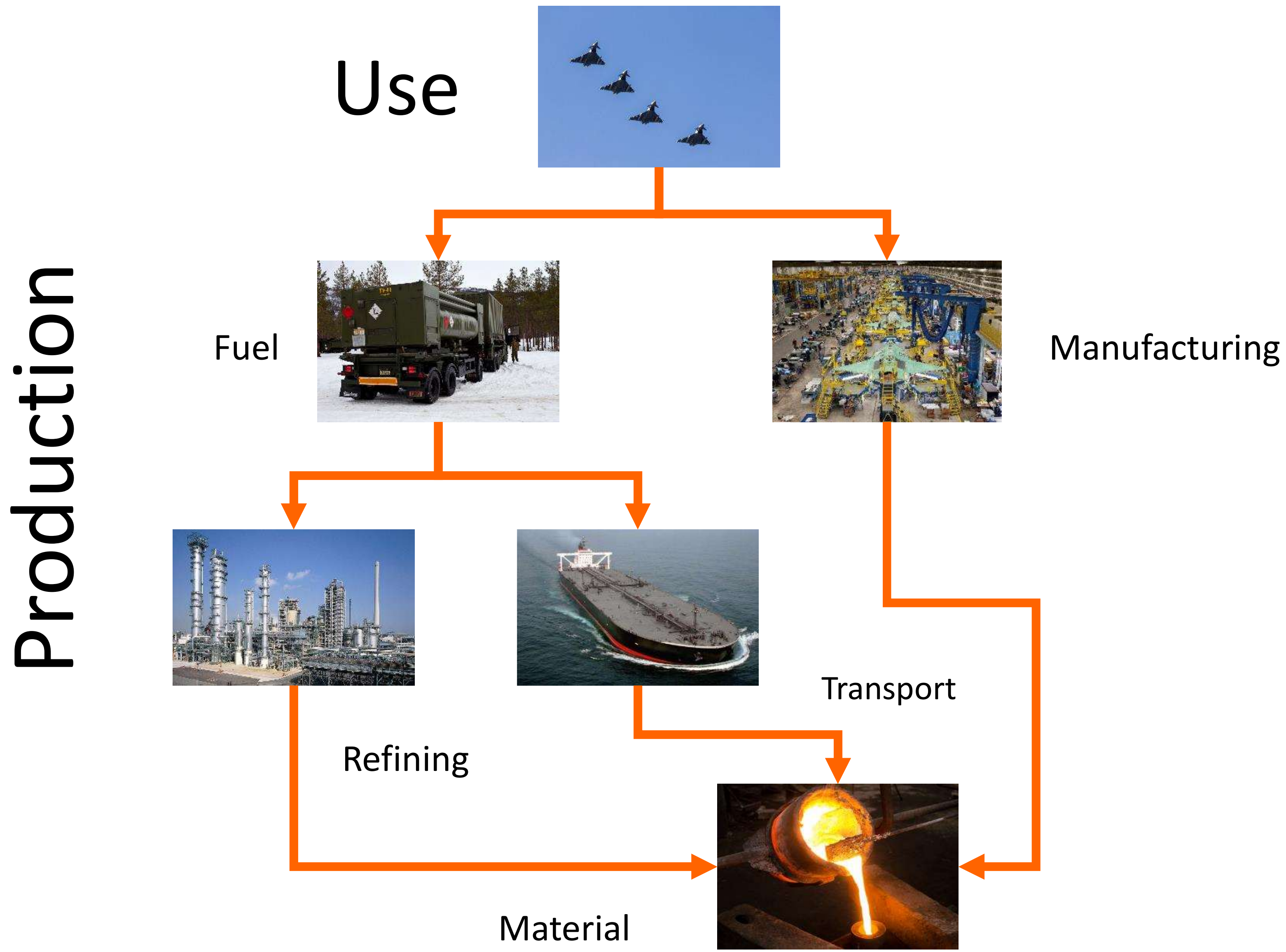
Compilation and evaluation of the inputs and outputs and the environmental impacts of a product system throughout its life cycle

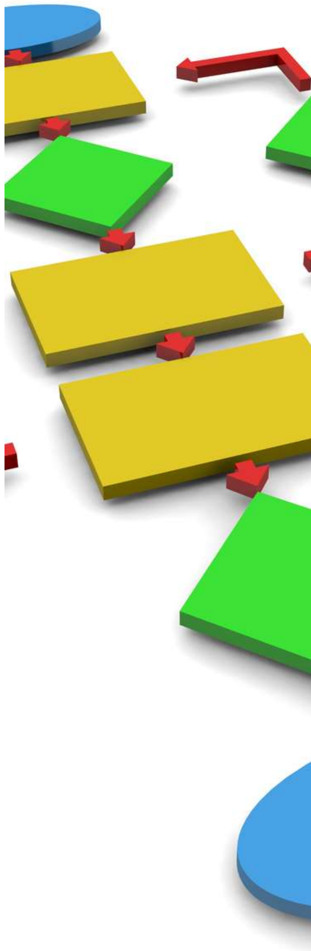
ISO 14040:2006 Environmental management. Life cycle assessment. Principles and framework

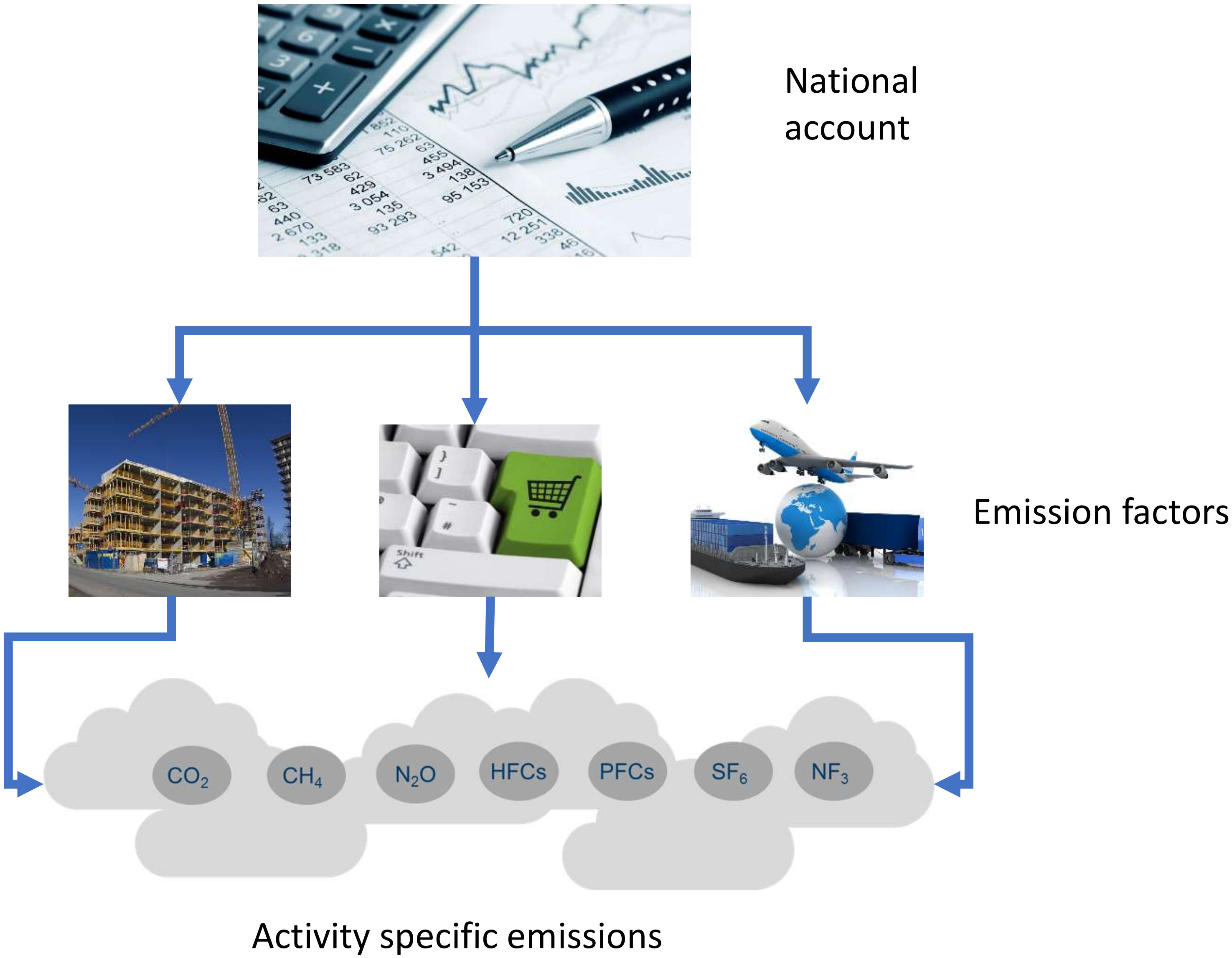


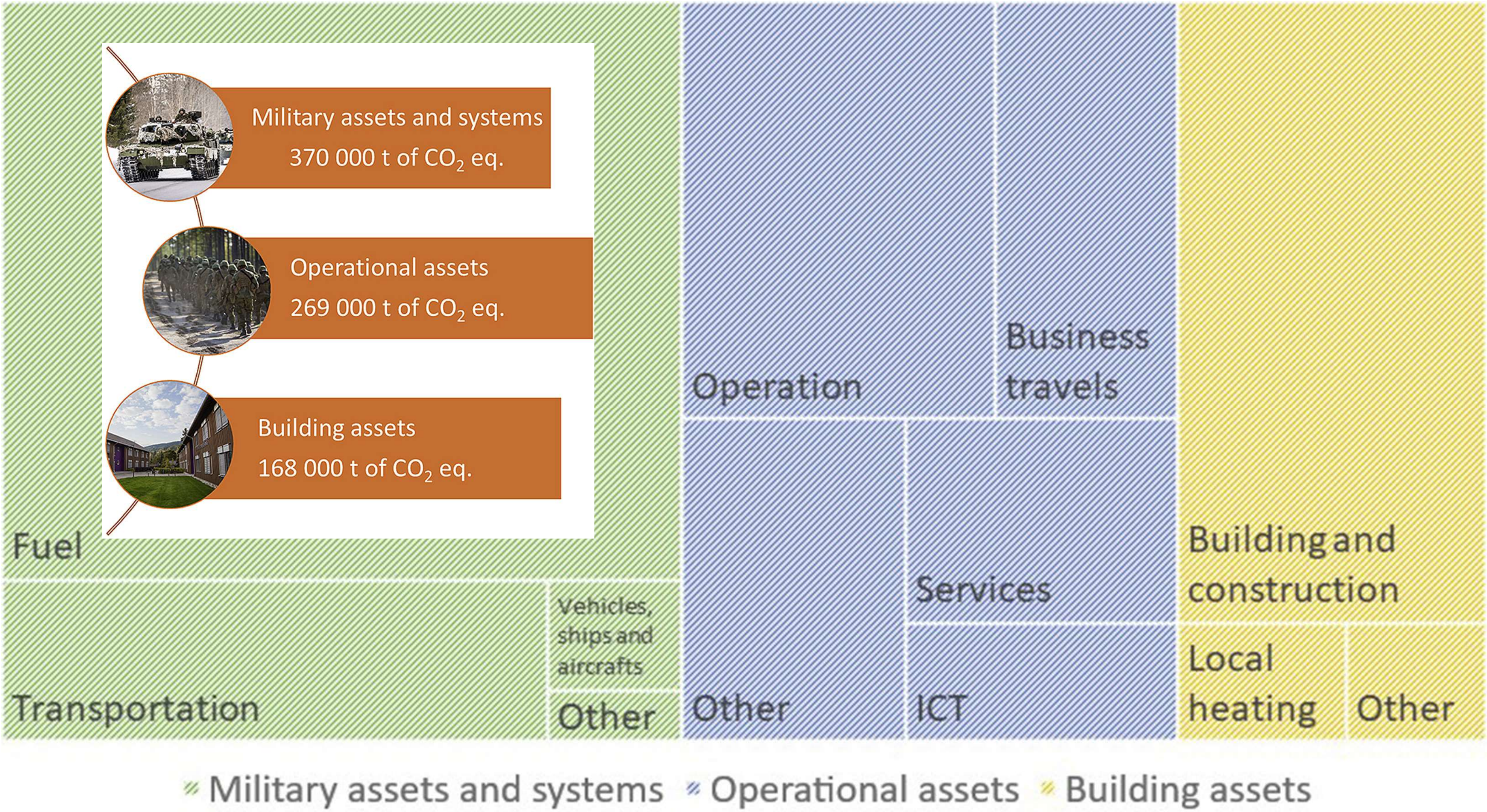


CO2
CO2
CO2
Scope 1
Direct
Scope 2
Indirect
Purchased energy
Production of vehicles, ships and aircrafs
Munitions production
Production of fuel
Chemical production
Water supply
Transportation of goods
Purchased goods and services
Building and construction
Business travels
Scope 3
Indirect
Fuel consumption
Heating of buildings
Ammunition use
Chemical use
Fugative emissions
Scope 3
Indirect
Water treatment
Waste management
Upstream activities
Reporting organisation
Downstream activities

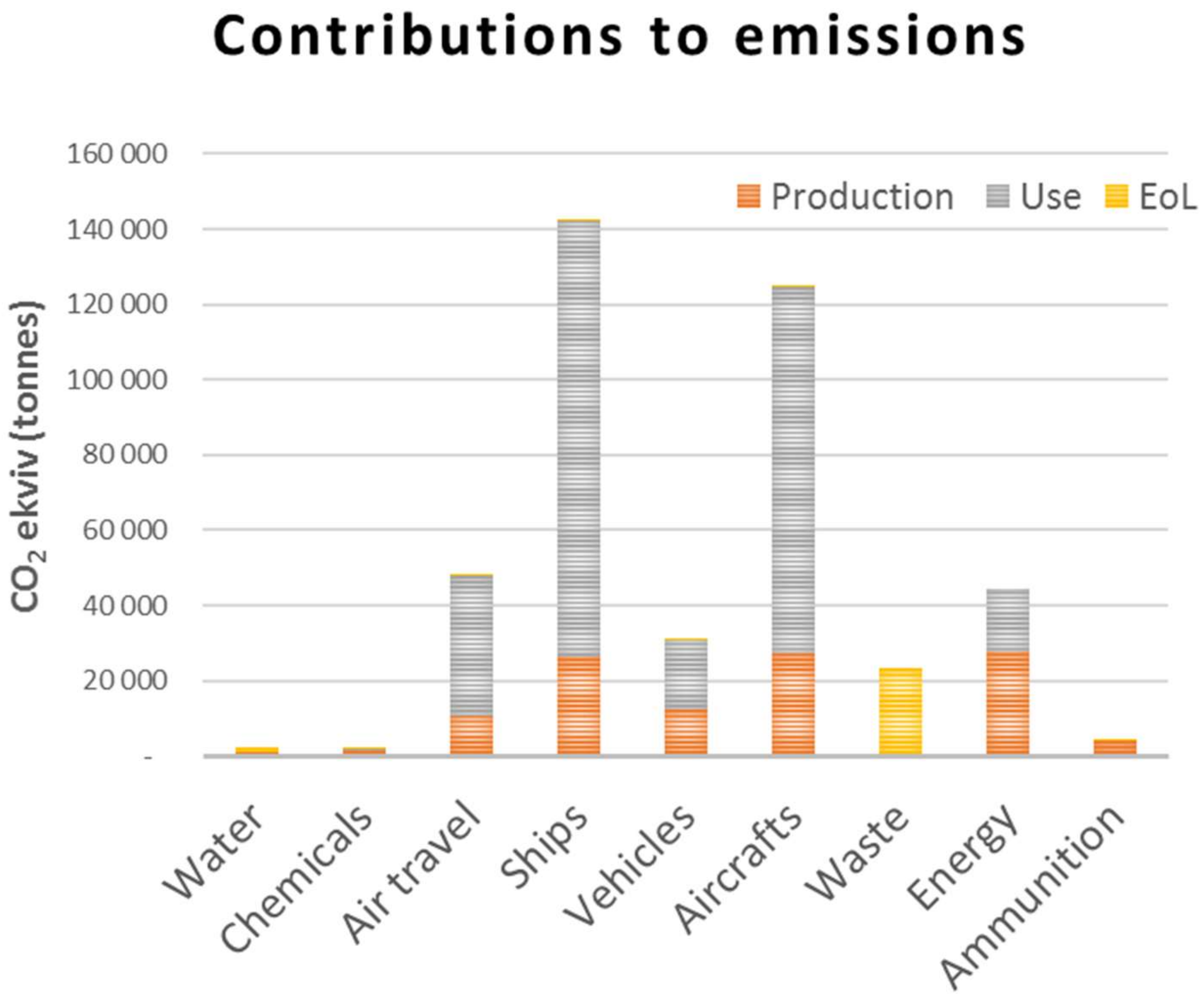

Use
Production
Fuel
Manufacturing
Transport
Refining
Material



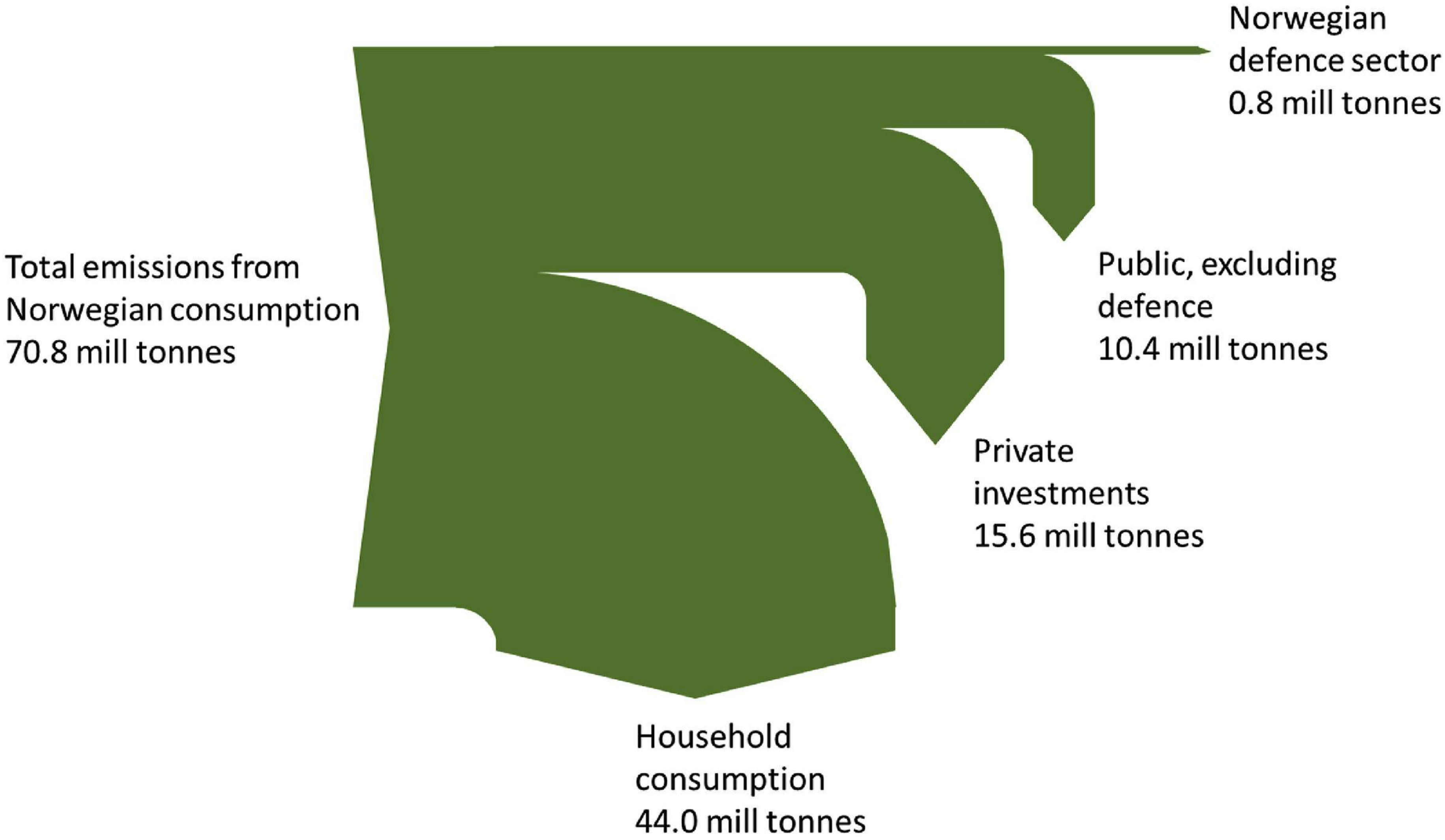

National account
Emission factors
CO_2
CH_4
N_2O
HFCs
PFCs
SF_6
NF_3
Activity specific emissions



Military assets and systems
370 000 t of CO_2 eq.
Operational assets
269 000 t of CO_2 eq.
Building assets
168 000 t of CO_2 eq.
Fuel
Transportation
Vehicles, ships and aircrafts
Other
Operation
Business travels
Other
Services
ICT
Building and construction
Local heating
Other
Military assets and systems
Operational assets
Building assets



Contributions to emissions
160 000
140 000
120 000
100 000
80 000
60 000
40 000
20 000
-
CO_2 ekviv (tonnes)
Production
Use
EoL
Water
Chemicals
Air travel
Ships
Vehicles
Aircrafts
Waste
Energy
Ammunition


Norwegian
defence sector
0.8 mill tonnes
Total emissions from
Norwegian consumption
70.8 mill tonnes
Public, excluding
defence
10.4 mill tonnes
Private
investments
15.6 mill tonnes
Household
consumption
44.0 mill tonnes

Limitations

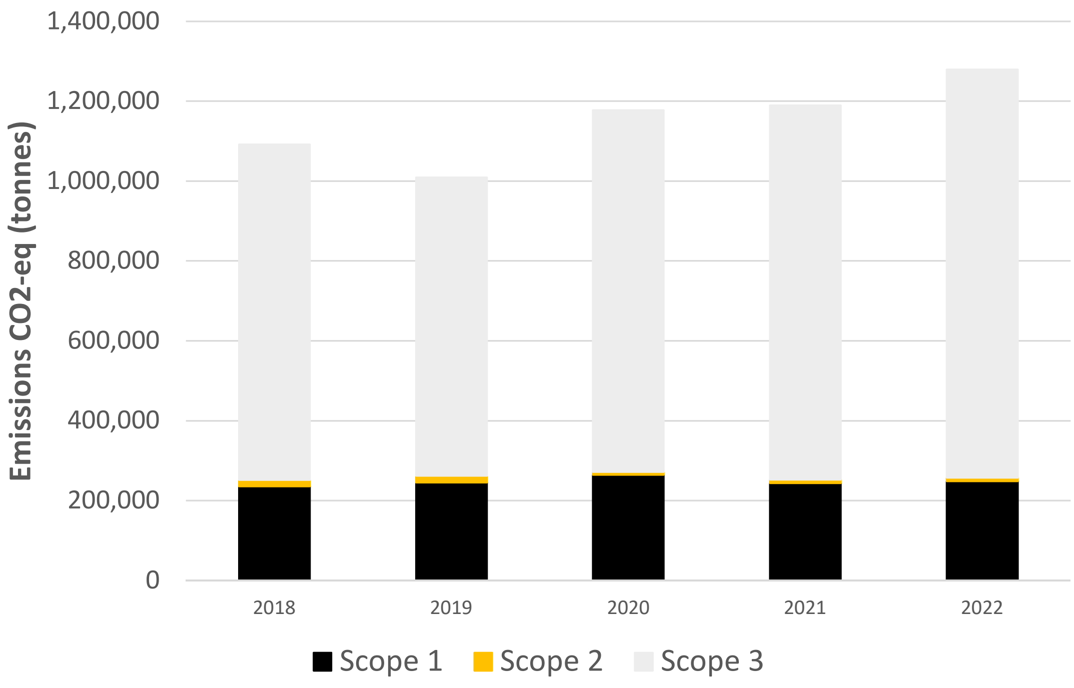
- No strategic military investments included
- Few LCA processes exist for military equipment
- The characterization factors for economic LCA are generic and not suitable for performance evaluation

Today

Publicly accessible GHG account includes scope 1-3. Both process and economic data are used.

[Forsvarssektorens miljø- og klimaregnskap for 2022 (ffi.no)]

FFI Norwegian Defence Research Establishment



Sparrevik, M, and Utstøl S. "Assessing life cycle greenhouse gas emissions in the Norwegian defence sector for climate change mitigation." Journal of Cleaner Production 248 (2020):

https://doi.org/10.1016/j.jclepro.2019.119196

magnus.sparrevik@ntnu.no

Military Emissions Gap Conference 2023

MILITARY AND CONFLICT GHG EMISSIONS: FROM UNDERSTANDING TO MITIGATION

Tuesday 26 September, University of Oxford, and online

CONCRETE IMPACTS

Conflict and Environment Observatory

Scientists for Global Responsibility

UNIVERSITY OF OXFORD

Queen Mary University of London

The Minor Foundation

‘Hidden’ carbon footprints: An examination of the US military’s use of concrete walls in Iraq

Military conflict emissions Oxford conference Sept. 26,2023

Dr Reuben Larbi

Dr Benjamin Neimark, Dr Kirsti Ashworth & Oliver Belcher

Funding made possible by the UKRI-ESRC Concrete Impacts Project

https://www.concreteimpacts.org/

Lancaster University · UKRI Economic and Social Research Council · Durham University · Queen Mary University of London · CONCRETE IMPACTS A SUPPLY CHAIN AND LIFE CYCLE ANALYSIS OF THE US MILITARY'S ENVIRONMENTAL FOOTPRINT

Introduction

- War and military intervention have damaging impacts on environment and humans
  - casualties, displacements, destruction to property and landscape, water pollution …
- The carbon footprint remains a major gap:
  - 2019 EU military =24.8 million tCO_2e, ~ emissions from 14 million average sized cars (Parkinson and Cottrell 2021)
  - US military would be 47th largest carbon emitter [country] based on fuel usage alone (Neimark et al. 2020)
  - Socio-ecological impacts of military operations remain poorly investigated

Objective: the carbon footprint from concrete walls used in the second Iraq war (2003-2008).

-

Why worry about the use of concrete?

- Concrete barriers are significant component of modern warfare and conflict control – Afghanistan, West Bank, Iraq
- Global consumption ~ 30 million tonnes annually
- Carbon intensive-> up to 8% of total global GHG
- 2nd most consumed material

Socio-economic Impacts of concrete walls

Segregated communities- Shiite and Sunni

Restricted movements & access to essential services

Vehicular traffic

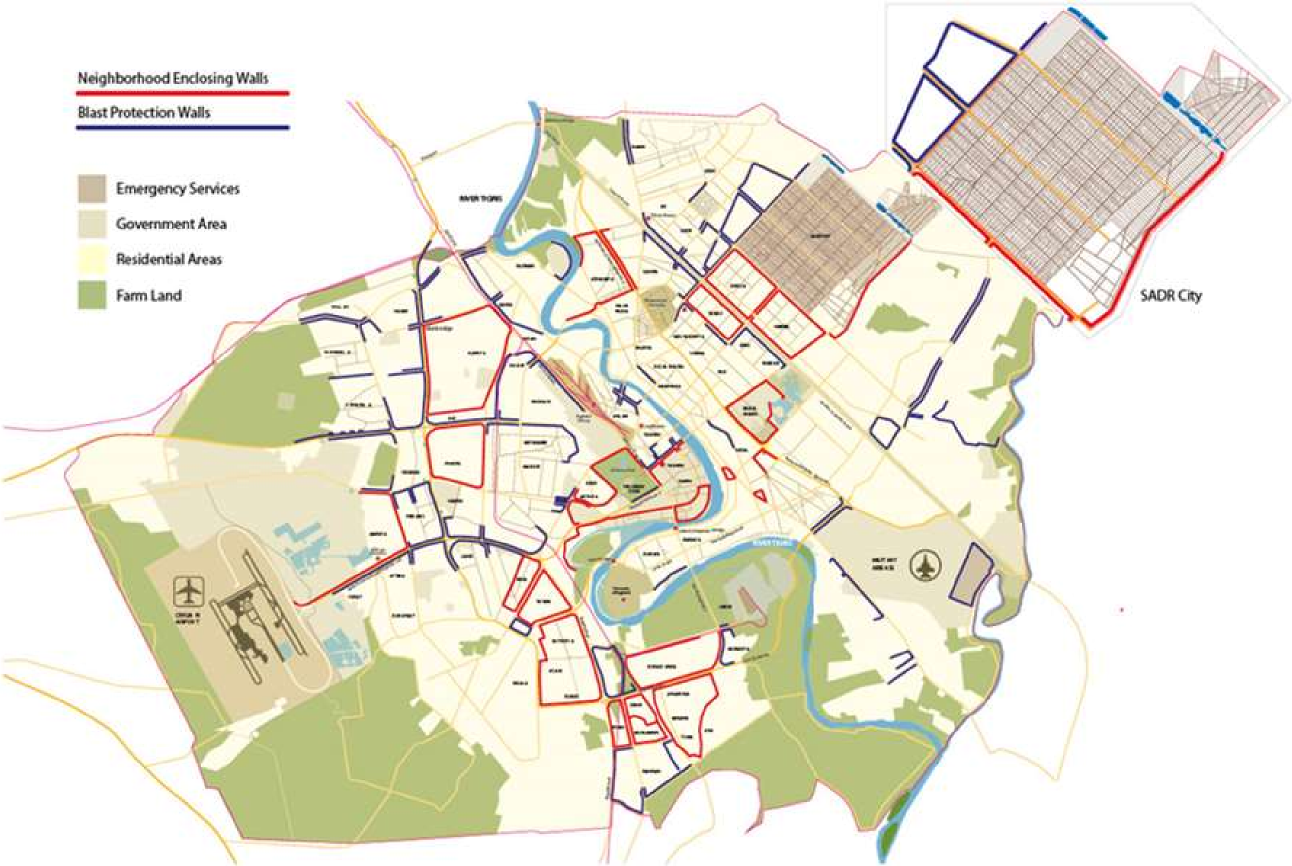
Restricted emergency services

Increased economic hardships

Altered urban fabric

Abated violence

Materials and Methods (1)



Total length of walls = 412 km

- Neighbourhood and blast protection walls
- Data deficit- wall lengths, barrier types, etc
- Fiji ImageJ to extract the length of walls from info graph (Gulf project, Columbia University)
- Constituents of concrete from standard M20 mixture- (PCA, 2007)

- $Embodied\ carbon(EC) = \sum_{k=0}^{n} Inputs\ * Emission\ Factors$

Emissions factors are from the Inventory of Carbon and Energy, 2019

Methods and Materials (2)

- **Estimation of total embodied carbon (EC)**

  - Three walling scenarios

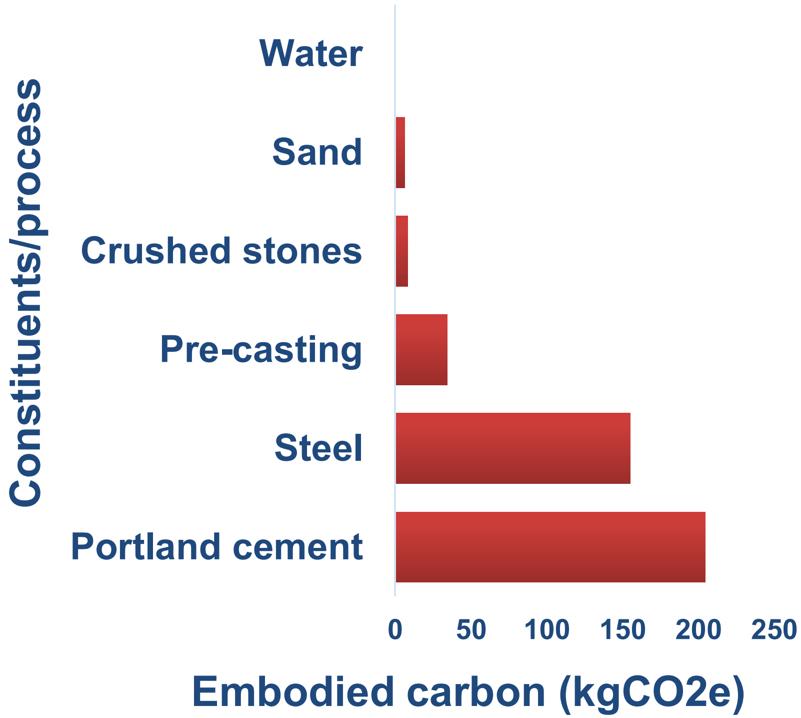
$$Total\ EC = \sum_{k=0}^{n} (EC\ of\ barrier\ type) * No.of\ barriers$$

- **Quantification of uncertainty**

  - Sources: Activity data & Emission factors
  - Method: Monte Carlo Simulation with 100,000 iterations
  - Mean and standard deviation computed

Results

CO2 emissions inventory to produce 1m3 of concrete



Type of concrete barrier and embodied carbon

Barrier type	Jersey	Texas	Alaska
Image (not drawn to scale)			
Volume of concrete (m^3)	0.96	3.02	4.78
Embodied carbon ($kgCO_2e/m^3$)	392.10	1233.49	1952.34

Lancaster University

Results (2)---- Total Embodied Carbon

Walling Scenario	Length of barrier (km)			Number of sections of barrier			Total EM (kt CO_2e)
	Jersey	Texas	Alaska	Jersey	Texas	Alaska	
S1	0	412	0	0	164, 648	0	203.0 $\pm$ 11.6
S2	0	412	0	0	253,924	0	313.2$\pm$ 17.9
S3	63	286	63	25,124	114,400	25,124	199.9 + 11.5

S1: All blast and neighbourhood walls are formed of Texas barriers

S2: All blast and neighbourhood walls are Texas barriers but blast walls are double layered

S3: All blast walls are Texas. Neighbourhood walls are an equal mix of single layer Jersey, Texas and Alaska

Discussion and conclusion

- We estimated 412 km of concrete T walls in Baghdad (2003-2008)
  - Using LCA -> 0.2 million tonnes of CO_2e
  - ~43, 000 typical passenger vehicles on the road for a year
  - ~ total annual emissions of a small island nation
- World Militaries emit 1%-5% of global GHG ~ Aviation & shipping industries
- Largely spared from emission reporting:
  - absence of accountability and hence reliable data
  - FOIA requests difficult to access data
- UNFCCC should develop a framework for military emission reporting including war time

Our Actions: Get the Science Right

- More research is needed
- **Work in progress**: a review paper on military emission gap

Our Actions: Get the word out

Panel discussion and media briefing on MEG at COP26

Adding to what we already know/don’t know

THE MILITARY EMISSIONS GAP

DATA · PROBLEM · SOLUTION · RESOURCES · ABOUT

View your government’s military emissions data

40 industrialised countries spent $1.2tn on their militaries in 2020.

Only 5 reported their emissions in line with UNFCCC guidelines.

15 countries, including China, India, Saudi Arabia, South Korea, Brazil, Iran and Pakistan spent $510 bn on their militaries in 2020.

None reported any disaggregated data on their military emissions to the UNFCCC.

Thank You!

https://www.concreteimpacts.org/

Military Emissions Gap Conference 2023

MILITARY AND CONFLICT GHG EMISSIONS: FROM UNDERSTANDING TO MITIGATION

Tuesday 26 September, University of Oxford, and online

CONCRETE IMPACTS

Conflict and Environment Observatory

Scientists for Global Responsibility

UNIVERSITY OF OXFORD

Queen Mary University of London

The Minor Foundation