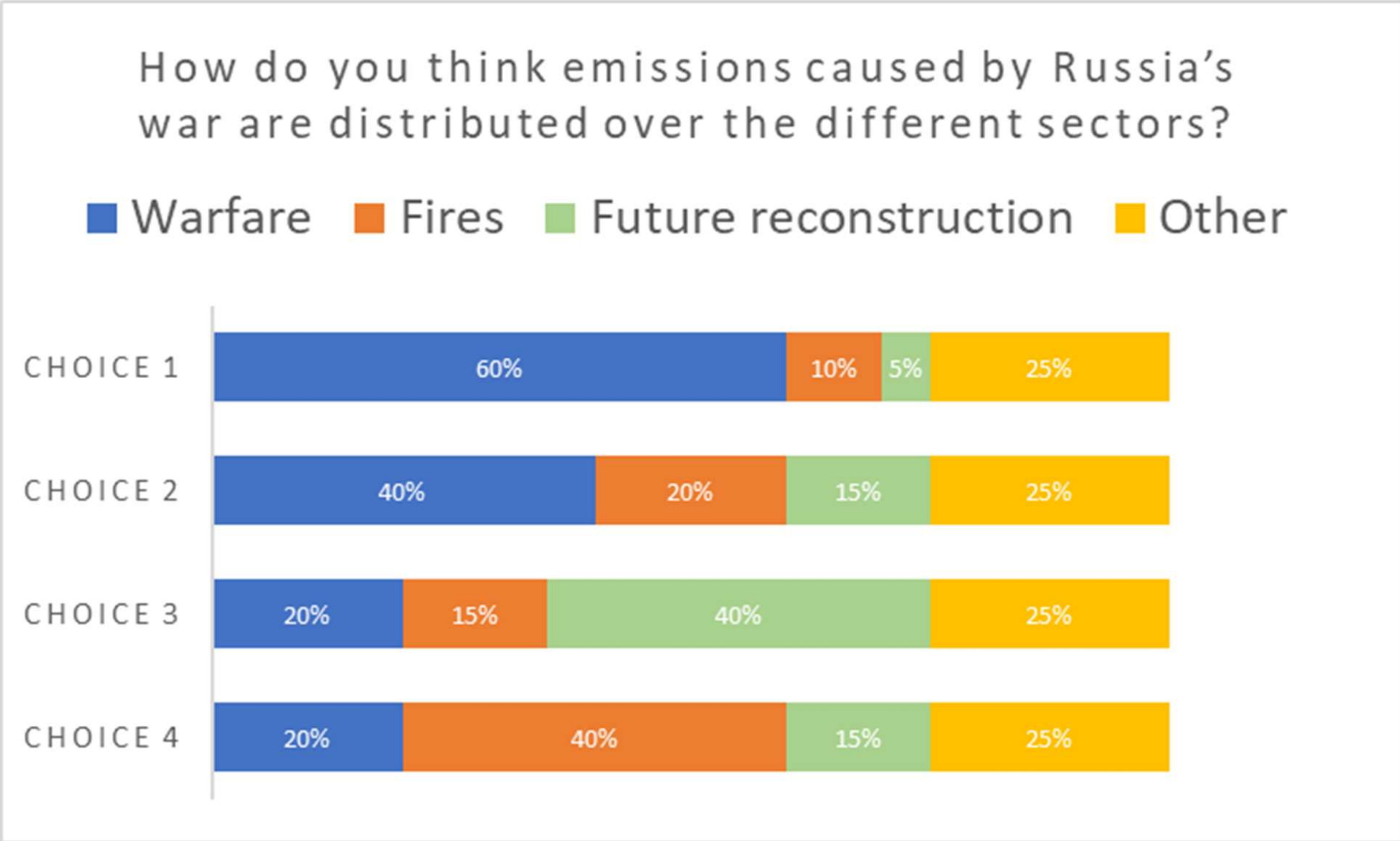
Military Emissions Gap Conference 2023

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 for Major Challenges

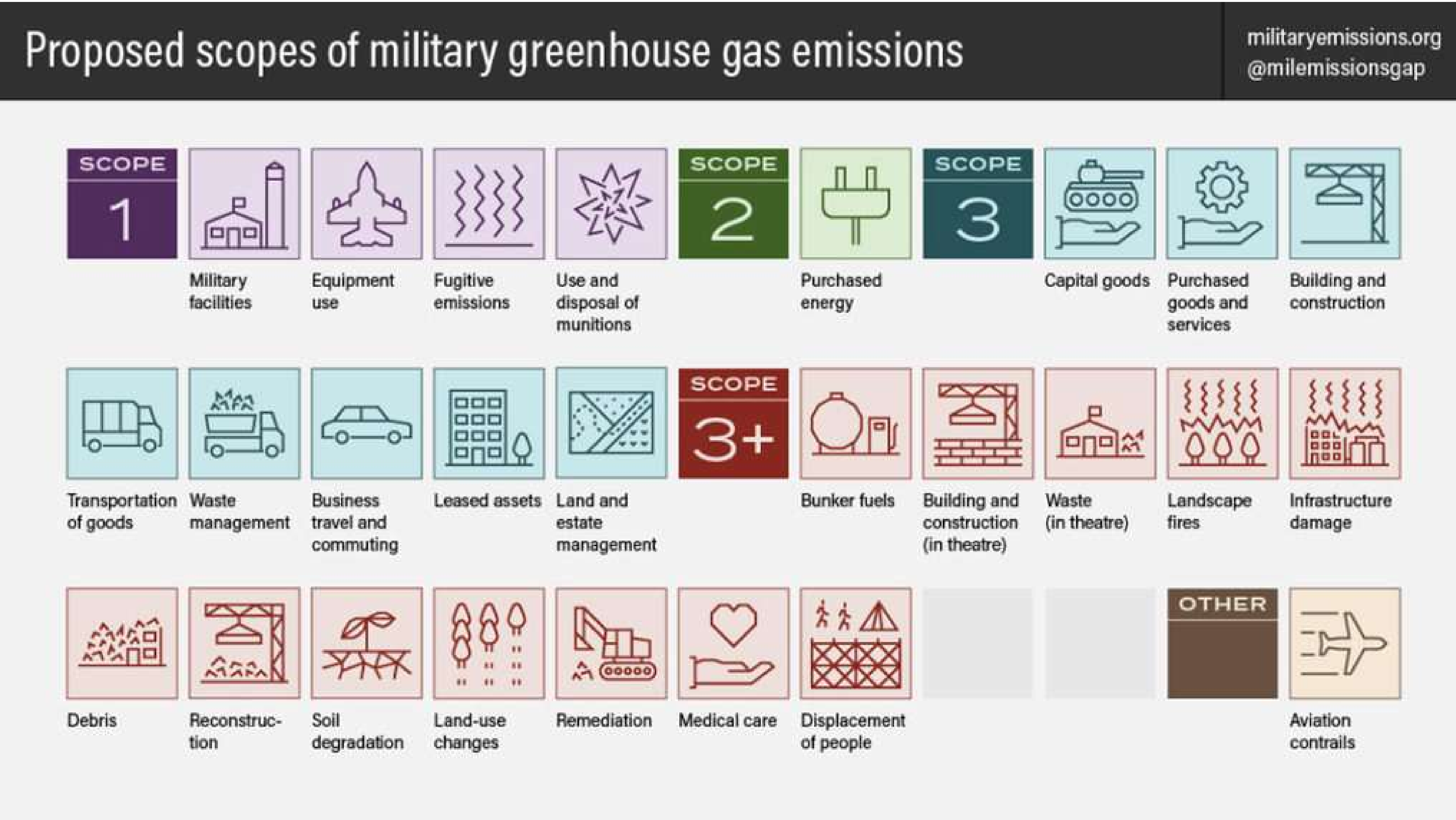
Poll question



Climate Damage caused by Russia’s war in Ukraine

Initiative on GHG accounting of war

Military and Conflict Emissions Conference
from understanding to mitigation
Oxford, 26 September 2023


Proposed scopes of military greenhouse gas emissions
militaryemissions.org
@milemissionsgap
SCOPE 1
Military facilities
Equipment use
Fugitive emissions
Use and disposal of munitions
SCOPE 2
Purchased energy
SCOPE 3
Capital goods
Purchased goods and services
Building and construction
Transportation of goods
Waste management
Business travel and commuting
Leased assets
Land and estate management
SCOPE 3+
Bunker fuels
Building and construction (in theatre)
Waste (in theatre)
Landscape fires
Infrastructure damage
Debris
Reconstruction
Soil degradation
Land-use changes
Remediation
Medical care
Displacement of people
OTHER
Aviation contrails

War as a 'carbon project'

Three elements of a carbon project:

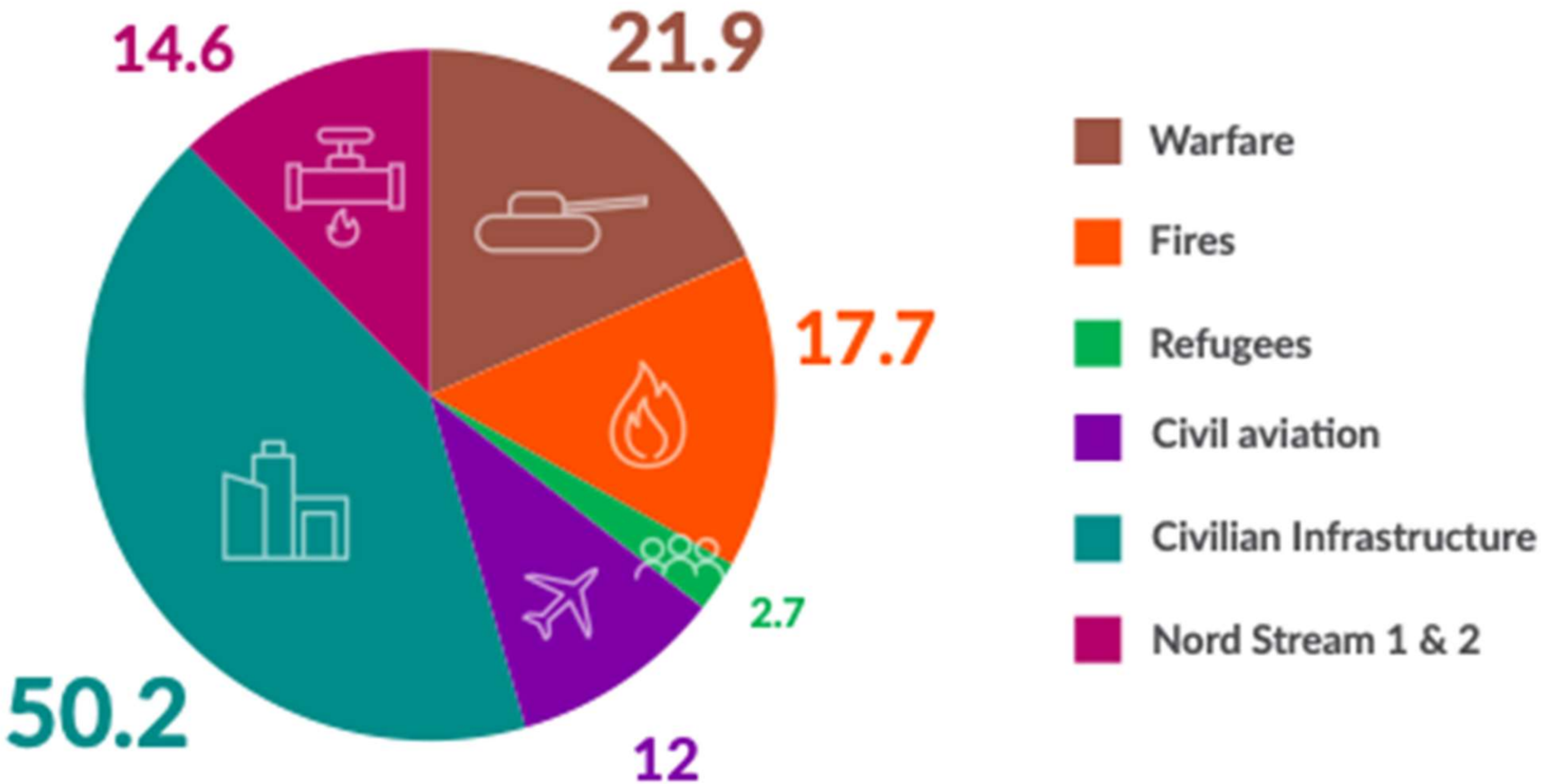
- Starting date
- Project boundary
- Baseline vs. project emissions

Starting date = Full-scale invasion on 24 February 2022

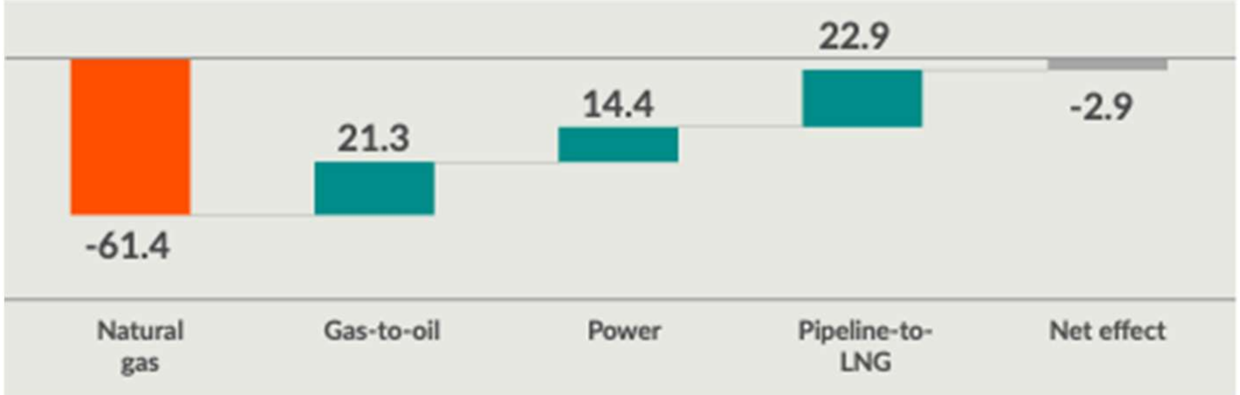
Project boundary:

- Geographical boundary: War theatre only or beyond?
- Direct emissions or indirect (embodied carbon) as well?
- Only past emissions or include future emissions?
- How to attribute events to the act of aggression?

Breakdown of sources ($MtCO_2e$)



Energy sector, aviation and country impact



Hold the aggressor accountable

Compensation mechanism:

- Make GHG emissions (climate damage) a category of the International Register of Damages (part of the International Compensation Mechanism of the Council of Europe)

Existing courts:

- International Court of Justice or International Criminal Court

UNFCCC:

- Account or compensate for these war emissions

Use the proceeds to mitigate emissions through a green recovery, e.g. minimize future reconstruction emissions

Next steps

COP28:

- Third report covering 555 days of war
- Climate Damage litigation
- Low-carbon recovery

Research agenda:

- Improve methodologies / alignment with IPCC guidelines
- Conflict emissions: will they be recorded in National Inventories?
- Other burst events: emissions from large military exercises

Second report: https://en.ecoaction.org.ua/climate-damage-by-russia-12-months.html

Contact: Lennard de Klerk, +36 30 3662983, lennard@klunen.com

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Warfare emissions caused by Russia's war in Ukraine

(24 February 2022 – 23 February 2023)

Initiative on GHG accounting of war

Military Emissions Gap Conference 2023

26 September 2023

Fog of war:

What GHGs emissions to count?
How to get activity data?
Which emission factors to use?

Photo: Bakhmut Town, 24th Separate Mechanized Brigade named after King Danylo, @DefenceU on X

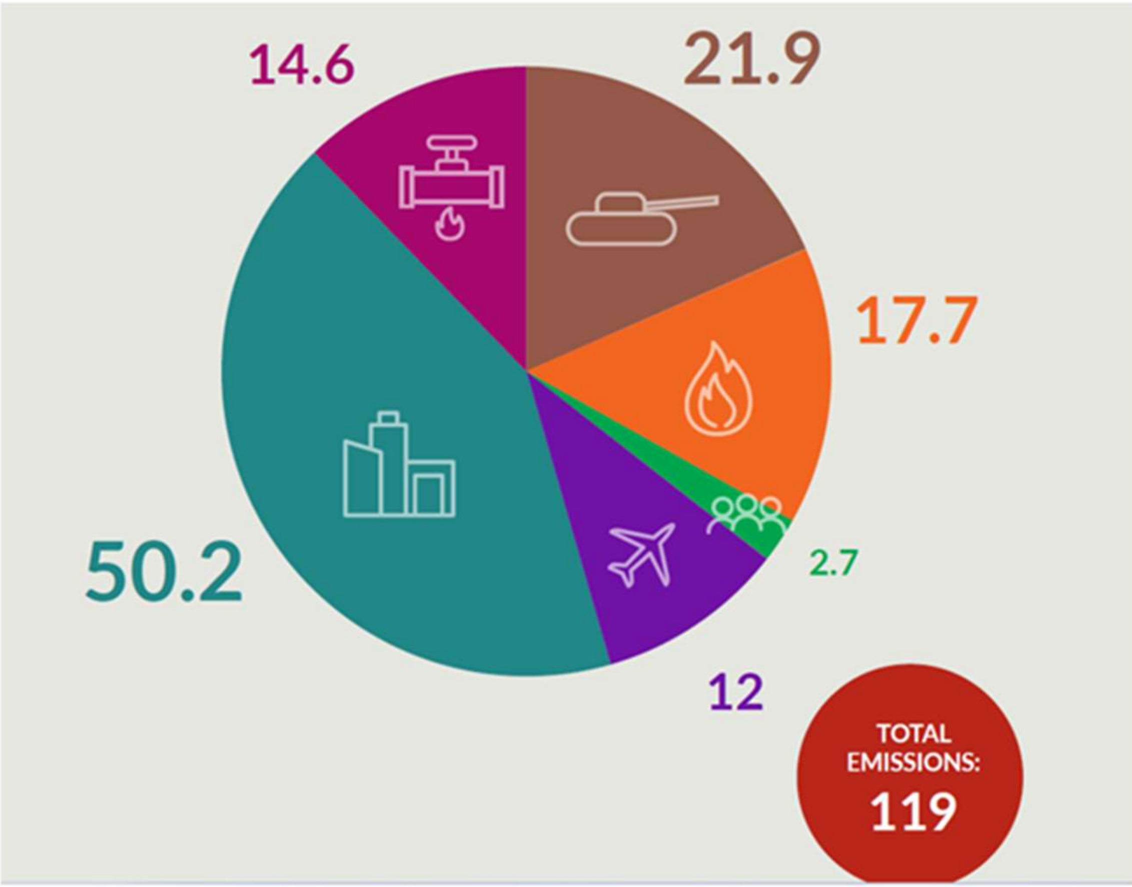
How have we assessed warfare emissions?

- **Step-by-step approach**: apply the helicopter view to map the key sources of emissions first and gradually extend the depth and scope of accounting.

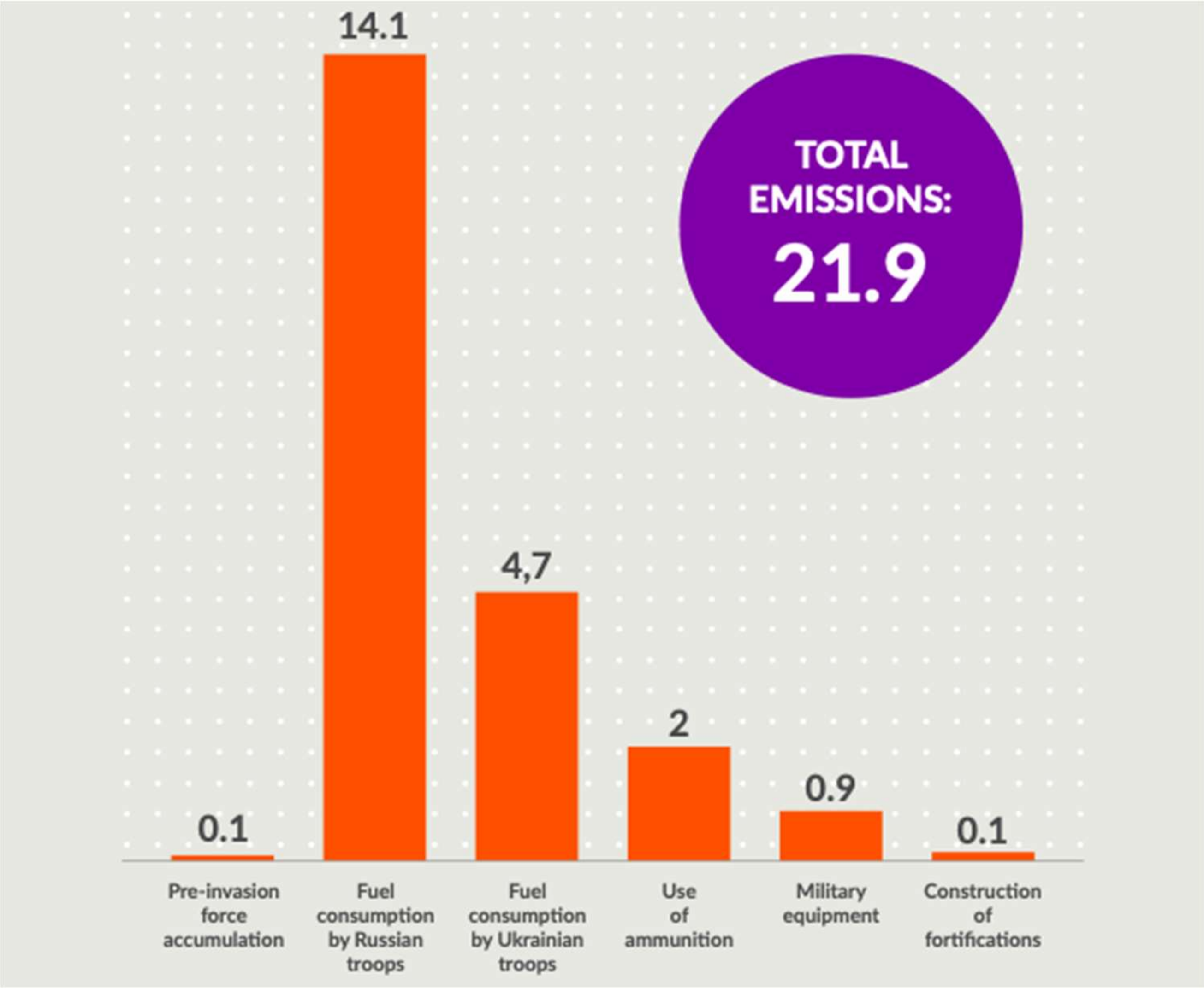
- **Finding allies and building alliances**: bringing together expertise from various fields (e.g. military, carbon accounting) and sectors (e.g. academics, OSINT community, think-tanks, journalists, etc.)

- **Gradual improvement of the accuracy**: focus on understanding the scale and the structure of warfare emissions sources and improve accuracy in the process where possible.

Warfare emissions in total estimated climate damage ($MtCO_2e$)



Warfare emissions by sources ($MtCO_2e$)



Fuel

- **18.8 $MtCO_2e$** of GHGs emissions during the first year of the war, including direct emissions from combustion and upstream emissions.
- Structure of fuel consumption depends on the nature of war and operations, including on the intensity of aviation use.
- No reliable activity data on fuel consumption: different top-down and bottom-up approaches were used for estimates.
- Average value from two different top-down approaches (based on reported fuel supplies via railway and personnel involved) was used in calculations.
- Bottom-up approach was used to test the reasonability of the estimates.

Emissions from logistical “tale” could be several times higher than emissions from “fighting tooth”.

Photo: Ministry of Defense of Ukraine, @DefenceU on X

Ammunition

- **2 $MtCO_2e$** of GHGs emissions from the use of artillery ammunition, other ammunition and explosives.
- Lifecycle approach: GHG emissions from manufacturing of ammunition and relevant raw materials, combustion of the propellant during firing, and detonation of the warhead at the point of impact.
- Estimates of artillery use intensity by both sides of the war during different periods of the war were used as key activity data.
- Research on lifecycle environmental impact of 155mm artillery shell along with carbon footprint of steel elements were used as emission factors.

Almost 98% of GHG emissions occur during manufacturing of ammunition and raw materials, while the remaining small fraction occurs during the use phase

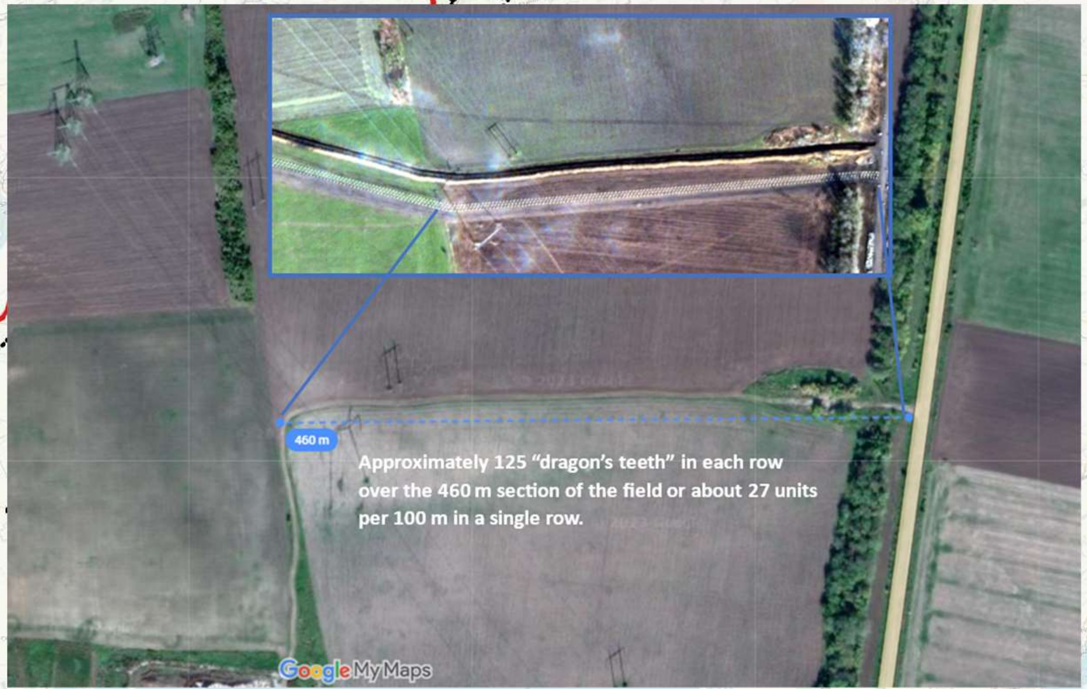
Photo: Ministry of Defense of Ukraine, @DefenceU on X

Fortifications

- **0.1 $MtCO_2e$** of GHGs emissions due to manufacturing of concrete and other materials used for the construction of fortifications

- Hundreds of kilometers of “dragon’s teeth” lines and hundreds thousand tons of carbon intensive concrete used

- Other emissions from the use of steel elements and construction



Military equipment

- **0.9 $MtCO_2e$** of GHGs emissions from the manufacturing of destroyed and damaged military equipment.
- Manufacturing of all machinery requires structural steels, alloyed steels, cast materials, light alloys, synthetic materials, and other carbon-intensive resources.
- Limited research is available on the carbon footprint of military equipment manufacturing and proxy estimates for other types of equipment have been applied.
- Military equipment manufacturers start reporting their carbon footprint data but limit the coverage to Scope 1 and Scope 2 emissions and do not provide data on the most significant Scope 3 emission categories, such as emissions from the manufacturing of materials and product use.

Key takeaways

- Warfare emissions are very significant and only a fraction of them occur on the battlefield. Supply chain emissions could be two to five times higher than operational emissions of the military.

- Significant volumes of emissions occur during manufacturing of ammunition and explosives, military equipment and machinery, as well as from fuel consumption of military logistical systems.

- While governments and businesses are struggling with achieving required volumes of GHGs emissions reduction Russia's invasion of Ukraine causes millions tons of additional emissions, redirects financial resources and puts at risk climate mitigation and adaptation efforts.

Download full report: https://en.ecoaction.org.ua/publication

Updated report will be presented at COP28

In Memoriam: Oleksii Khabatiuk

(19 September 1977 – 4 May 2023)

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Military and Conflict Emissions Conference: from understanding to mitigation

Oxford, 26 September 2023

Carbon emission from landscape fires in Ukraine during Russian military invasion

Sergiy Zibtsev, Volodymyr Pasternak, Viktor Myroniuk, Roman Vasylyshyn, Oleksandr Soshenskyi

Regional Eastern Europe Fire Monitoring Center (REEFMC), Kyiv, Ukraine

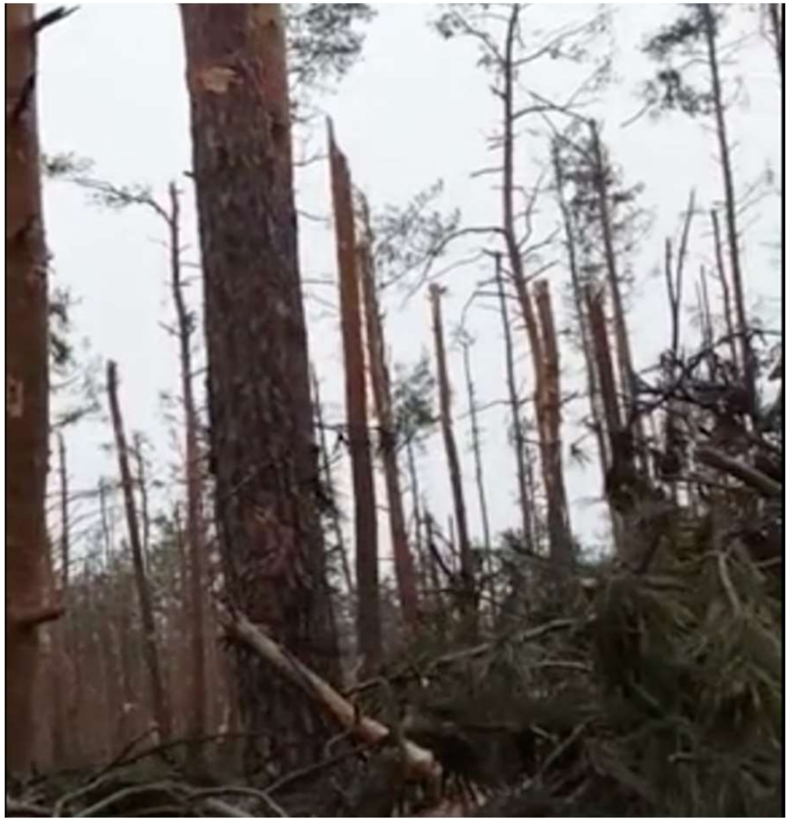
Nikolai Denisov

ZOI Environmental Network, Geneva, Switzerland

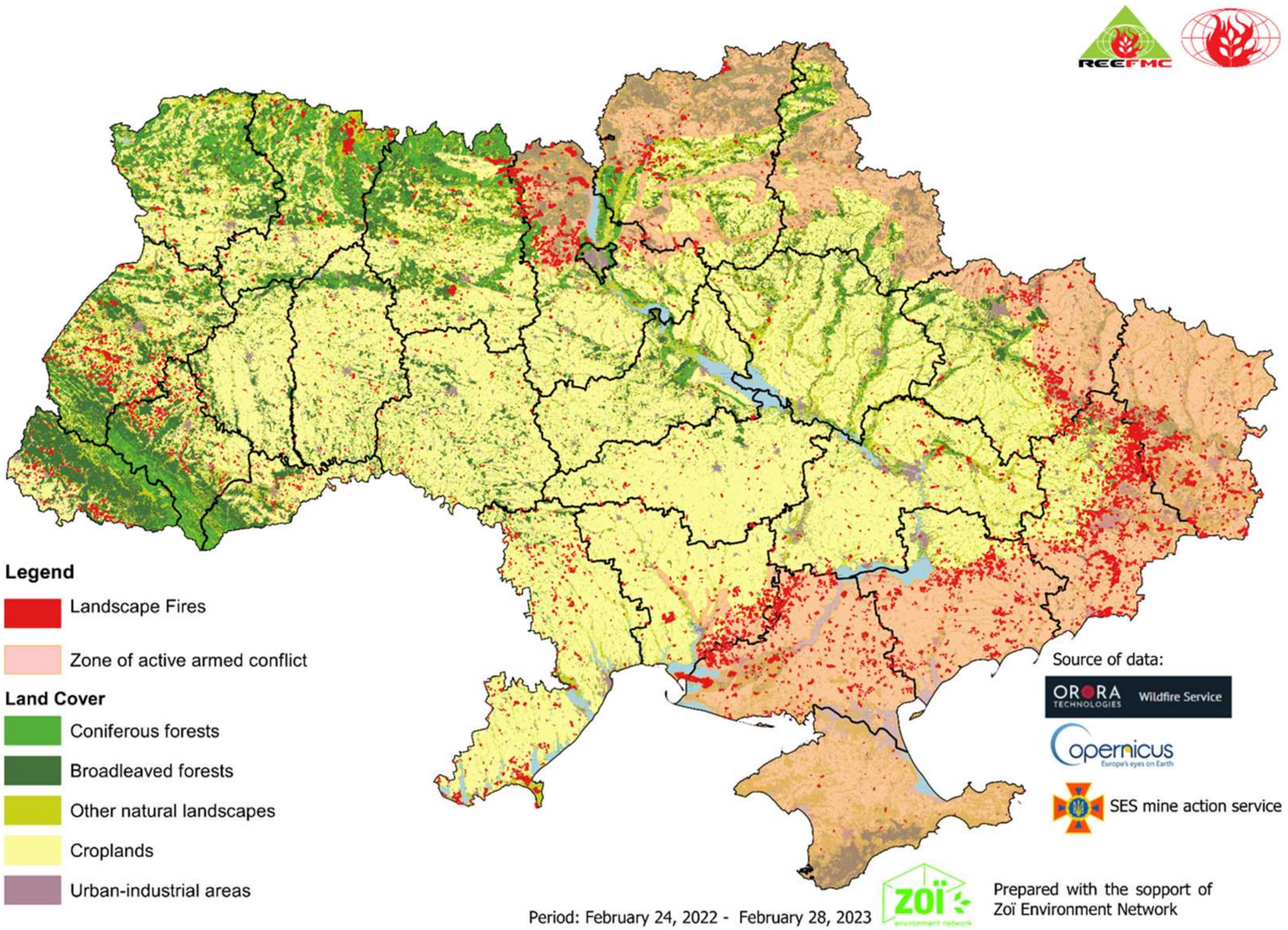
Wildfires caused by rocket launchers and artillery / mortars

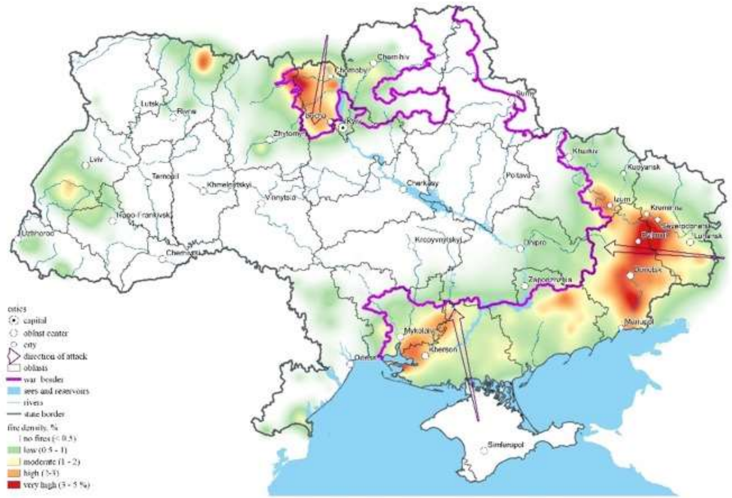
Mykolaiv Oblast, 9 August 2022

Wildfires caused by rocket launchers and artillery / mortars



Landscape fires related with Russian military invasion





Methods: fire mapping

- Surface reflectance time series of **Sentinel 2** imagery (Level 2A) were used to map fire perimeters based on ignition locations and dates of fires (14-days time window)
- Distribution of **burned land cover types** within fire perimeters were mapped using the Copernicus Dynamic Land Cover map (100 m resolution of 2019).
- **Burn severity** was mapped using the delta NBR (dNBR, Normalized Burn Ration) approach. Pre-fire image mosaics were created by selecting those pixels that had the highest NBR values in 40-day window before fires.
- **The dNBR values** were calculated within 5, 10, 15, …, 40 days intervals after fires.
- We calculated for all regions of Ukraine **average values of burn severity classes** by land cover types (coniferous, deciduous forests, croplands, other natural vegetation).

Methods: carbon emissions from forest fires

- Determine the species and age structure of forest stands based on the data of the current forest inventory of Ukraine for each region of Ukraine
- Estimate the total volume of biomass based on biomass models: coniferous (pine, spruce), deciduous (oak, beech, birch, aspen, and alder)
- Estimate the volume of biomass losses as a result of forest fires of different severity
- Surface, canopy (crown) or combined forest fires form different degrees of damage. This step in the carbon emission estimation algorithm is based on available fragmentary scientific data and expert assessments

Methods: fires on croplands and grasslands

- Determination of the dominant species structure of the sown areas of agricultural crops
- Estimation of yield and volume of biomass of agricultural crops within each oblast is determined on the basis of national statistics data
- The amount of biomass is determined by the coefficients of the total yield of surface and root residues of agricultural crops depending on the yield of the main products
- Estimation of biomass losses as a result of fires of different severity
- In the 60-km buffer zone during May-July biomass losses due to a high density of shelling

Results

Land category	Burned area, ha	Biomass loss, t	Biomass loss, t·ha^{-1}	Carbon loss, t	Carbon loss, t·ha^{-1}	CO_2 emission, t	Other GHG, t
Coniferous Forest	31126.5	331915.2	10.66	142718	4.59	523298	50553
Cropland	419123.9	1904697.5	4.54	857114	2.05	3142751	151516
Other Forest	25540.3	165735.6	6.49	68741	2.69	252051	24349
Other Natural Vegetation	273745.2	775811.7	2.83	349115	1.28	1280089	61715
Total	749535.9	3178160	4.33	1417688	1.89	5198189	288133

Discussion: uncertainties and needs in collecting field data

- For the moment only few studies were devoted to the carbon emissions assessment from landscape fires during war in Ukraine that were related to big gaps in data to provide such calculations
- Among them the most completed assessment of the joint team of de Klerk et al., 2022, 2023
- Good overview of the problems and assessments done in Politico’s article “There’s a Battle Over Carbon Emerging from the War in Ukraine” from 9.03.2023
- Burnt factor coefficients of forest biomass losses as a result of forest fires contains uncertainties
- Distribution of stands by composition and age according to forest inventory data may not fully correspond to the area of damaged stands
- Not all surface fires of low intensity are taken into account

Conclusions

- Carbon dioxide emissions from landscape fires during 2022 in Ukraine reached 5.48 million tons.
- The largest amount of carbon emissions occurred during fires on croplands (59%) and grasslands that are not cultivated (24%). Forest fires emitted more than 16.9% of total carbon emissions (12.6% from fires in pine forests and 4.3% in deciduous and mixed forests).
- Average carbon losses per 1 ha during fires in coniferous forests were more than 2 times higher compared to other landscape types and deciduous forests.

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Akademia WSB
Dąbrowa Górnicza, Kraków, Cieszyn, Żywiec, Olkusz, Gliwice, Tychy
WSB University

Tracking unaccounted greenhouse gas emissions due to the war in Ukraine since 2022

Rostyslav Bun
Lviv Polytechnic National University, Ukraine
WSB University, Poland

Photo: Rostyslav Bun

Countries with the highest GHG emissions

Country	CO2 emissions 2019 (Mt)	CO2 emissions 2020 (Mt)	CO2 per capita 2019 (tons)	CO2 per capita 2020 (tons)
China	9,876.50		7.1	
United States	4,744.50	4,285.90	14.4	13
India	2,310		1.7	
Russia	1,640.30	1,555.90	11.4	10.8
Japan	1,056.20	1,024.10	8.4	8.2
Germany	644.10	585.30	7.8	7
South Korea	585.70	570.70	11.3	11
Iran	583.50		7	
Indonesia	583.40	626.60	2.2	2.3
Canada	571	523.20	15.2	13.8
Saudi Arabia	495.20		14.5	
South Africa	433.60		7.4	
Mexico	419.40	381	[illegible]	[illegible]
Brazil	411	385.[illegible]	[illegible]	[illegible]
Turkey	366.40	366.[illegible]	[illegible]	[illegible]
United Kingdom	342.20	306.[illegible]	[illegible]	[illegible]

Source: https://worldpopulationreview.com/country-rankings/greenhouse-gas-emissions-by-country

Shares in 2022 global emissions, yearly GHG emission relative changes

	Share in global	Change 2019-2020	Change 2020-2021	Change 2021-2022	Change 2019-2022	Change 2020-2022	CAGR (1990-2022)
China	29.2%	1.9%	5.1%	0.3%	7.4%	5.4%	4.3%
United States	11.2%	-8.7%	5.5%	1.6%	-2.2%	7.2%	-0.1%
India	7.3%	-5.7%	6.7%	5.0%	5.7%	12.1%	3.2%
EU27	6.7%	-7.7%	5.6%	-0.8%	-3.4%	4.7%	-1.0%
Russia	4.8%	-3.9%	7.2%	-1.0%	2.0%	6.1%	-0.5%
Brazil	2.4%	-0.3%	5.1%	-2.4%	2.3%	2.6%	2.0%
Indonesia	2.3%	-4.9%	2.1%	10.0%	6.8%	12.3%	3.4%
Japan	2.2%	-5.3%	1.2%	0.6%	-3.6%	1.8%	-0.3%
Iran	1.8%	-1.6%	3.9%	1.6%	3.9%	5.6%	3.3%
Mexico	1.5%	-6.5%	3.5%	7.1%	3.7%	10.9%	1.8%
Saudi Arabia	1.5%	-0.8%	3.3%	3.9%	6.4%	7.3%	3.9%
Canada	1.4%	-8.2%	3.0%	3.2%	-2.4%	6.4%	0.8%
South Korea	1.3%	-4.3%	4.5%	-0.7%	-0.8%	3.7%	2.5%
Türkiye	1.3%	3.5%	8.5%	3.1%	15.8%	11.9%	3.5%
Australia	1.1%	-3.9%	-2.0%	1.7%	-4.1%	-0.3%	0.7%
South Africa	0.99%	-9.8%	-0.5%	-2.5%	-12.5%	-3.1%	0.8%
Global		-3.7%	4.8%	1.4%	2.3%	6.2%	1.5%
International Aviation	0.8%	-52.3%	15.4%	23.3%	-32.1%	42.3%	[illegible]
International Shipping	1.4%	-8.5%	5.7%	5.7%	2.2%	11.7%	[illegible]

Source: https://edgar.jrc.ec.europa.eu/report_2022

2023 Annex I Party GHG Inventory Submissions to the UNFCCC

Party	Date of CRF original submission	Latest submitted NIR	Latest submitted CRF [1]	Latest submitted SEF	Status Report
Australia[2]	13 April 2023	NIR 13 Apr 2023	CRT 13 Apr 2023	SEF-CP1-2022 14 Apr 2023 SEF-CP2-2022 14 Apr 2023	
Austria	13 April 2023	NIR 13 Apr 202		SEF-CP1-2022	
Belarus	14 April 2023	NIR 14 Apr 202			
Belgium	14 April 2023	NIR 14 Apr 202			
Bulgaria	12 April 2023	NIR 12 Apr 202			
Canada	14 April 2023	NIR 14 Apr 202 Additional Informatio 27 Jul 2023			

Source: https://unfccc.int/ghg-inventories-annex-i-parties/2023

IPCC 2006 Guidelines: Common Reporting Format

1	**TABLE 1 SECTORAL REPORT FOR ENERGY**							Inventory 2021
2	**(Sheet 1 of 2)**							Submission 2023 v1
3								UKRAINE
4								
5	**GREENHOUSE GAS SOURCE AND SINK CATEGORIES**	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
6					(kt)			
7	**Total Energy**	159735.73	1939.04	5.14	551.04	721.18	521.09	615.83
8	**A. Fuel combustion activities (sectoral approach)**	157482.55	14.88	5.14	551.04	721.18	418.75	615.83
9	**1. Energy industries**	84810.85	3.52	1.13	173.67	33.15	4.05	481.27
10	a. Public electricity and heat production	80546.08	2.76	1.11	166.15	30.46	3.86	474.33
11	b. Petroleum refining	423.27	0.02	0.00	0.78	0.13	0.01	2.25
12	c. Manufacture of solid fuels and other energy industries	3841.50	0.75	0.02	6.73	2.56	0.18	4.69
13	**2. Manufacturing industries and construction**	20926.56	1.29	0.18	35.11	97.88	14.55	86.88
14	a. Iron and steel	11331.73	0.72	0.10	18.38	58.53	7.97	53.19
15	b. Non-ferrous metals	925.82	0.05	0.01	1.45	4.34	0.60	3.95
16	c. Chemicals	412.53	0.01	0.00	0.57	0.36	0.19	0.11
17	d. Pulp, paper and print	53.23	0.00	0.00	0.07	0.03	0.02	0.00
18	e. Food processing, beverages and tobacco	579.05	0.03	0.00	0.87	1.50	0.40	1.04
19	f. Non-metallic minerals	4715.93	0.36	0.05	9.15	29.67	3.61	27.53
20	g. Other *(please specify)*	2908.26	0.11	0.01	4.63	3.43	1.75	1.05
21	**3. Transport**	32337.59	9.08	3.70	311.98	559.77	386.21	36.94
22	a. Domestic aviation	187.84	0.00	0.01	0.55	0.28	0.98	0.05
23	b. Road transportation	24351.21	8.35	1.42	140.83	407.83	69.15	24.37
24	c. Railways	376.68	0.02	0.15	5.73	4.78	0.96	2.25
25	d. Domestic navigation	82.33	0.01	0.00	1.54	0.62	0.21	0.54
26	e. Other transportation	7339.53	0.70	2.13	163.32	146.27	314.92	9.73
27								

Index sheet | Table1s1 | Table1s2 | Table1.A(a)s1 | Table1.A(a)s2 | Table1.A(a)s3 | Table1.A(a)s4 | Table1.A(b) | Table1.A(c) | Table1.A(d) | Table1.B.1 | Table1.B.2 | Table1.C | Table1.D | Table2(I)s1

The war suddenly overrides the enormous efforts of many scientists and policy makers

	GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
6		(kt)						
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8	**A. Fuel combustion activities (sectoral approach)**	157482.55	14.88	5.14	551.04	721.18	418.75	615.83
9	**1. Energy industries**			1.13	173.67	33.15	4.05	481.27
10	a. Public electricity and heat production			1.11	166.15	30.46	3.86	474.33
11	b. Petroleum refining			0.00	0.78	0.13	0.01	2.25
12	c. Manufacture of solid fuels and other energy industries			0.02	6.73	2.56	0.18	4.69
13	**2. Manufacturing industries and construction**			0.18	35.11	97.88	14.55	86.88
14	a. Iron and steel			0.10	18.38	58.53	7.97	53.19
15	b. Non-ferrous metals			0.01	1.45	4.34	0.60	3.95
16	c. Chemicals			0.00	0.57	0.36	0.19	0.11
17	d. Pulp, paper and print			0.00	0.07	0.03	0.02	0.00
18	e. Food processing, beverages and tobacco			0.00	0.87	1.50	0.40	1.04
19	f. Non-metallic minerals			0.05	9.15	29.67	3.61	27.53
20	g. Other (*please specify*)			0.01	4.63	3.43	1.75	1.05
21	**3. Transport**			3.70	311.98	559.77	386.21	36.94
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Fossil fuels ?
Industrial proc. ?
Agriculture ?
Forestry ?
Waste ?

Overriding reporting system: This is not a new problem

Gulf war (1991): Kuwait oil fires

Carbon Dioxide Information Analysis Center (CDIAC): Data

1	Nation	Year	Total CO2 emissions from fossil-fuels and cement production (thousand metric tons of C)	Emissions from solid fuel consumption	Emissions from liquid fuel consumption
9172	KUWAIT	2017	26211		13908
9173	KUWAIT	2018	26581		14134
9174	KUWAIT	2019	28682		15147
9175	KUWAITI OIL FIRES	1991	130438		123118
9176	KYRGYZSTAN	1992	3014	1041	1006
9177	KYRGYZSTAN	1993	2315	938	663
9178	KYRGYZSTAN	1994	1675	934	225

Source: Hefner, M., Marland, G., Boden, T., Andres, R., 2022. Global, Regional, and National Fossil-Fuel CO_2 Emissions: 1751-2019 CDIAC-FF

2014 Russia invasion: Occupied territories

Area: 43,300 km^2 (> the Netherlands' area 41,500 km^2)

Industrial regions: iron and steel production, cokes, coal mining etc.

Ukraine's NIRs for 2014-2021:

"… for emission and reduction estimations on temporarily occupied by the Russian Federation territory of Ukraine expert estimation was performed …"

What with uncertainty of such an estimate?

GHG emissions caused by military actions in Ukraine that have a chance of not being accounted for in official national reporting

6

1. The use of bombs, missiles, barrel artillery, mines, and small arms

GHG emissions occur during:
- firing (barrel artillery and small arms),
- flight to the destination (missiles and drones),
- explosions (missiles, bombs, shells, grenades, drones, and mines).

18 months of the war: Emissions – 283.3 $ktCO_2$

2. The use of petroleum products for military actions

Both armies:
armored combat vehicles, self-propelled artillery system, tanks, multiple launch rocket systems, aircrafts, helicopters, trucks, ships etc.

18 months of the war: Emissions – 28.69 $MtCO_2$-eq., including: 26.80 $MtCO_2$-eq. from the land military vehicles, 1.03 $MtCO_2$-eq. from aviation, 0.86 $MtCO_2$-eq. from ships.

3. Fires of petroleum products at petroleum storage depots

Destroyed due to missile attacks and shelling:

- petroleum storage depots,
- oil refineries,
- petroleum stations,
- petrol trucks.

Occupied as well as not-occupied territories.

18 months of the war:
Emissions – 5.43 $MtCO_2$-eq.

4. Fires in buildings and other infrastructure

Wooden constructions and things:
floors, windows and doors, furniture, roof constructions, auxiliary buildings, fences, etc.
Other combustible materials:
plastics, fabrics, clothes/shoes, books, etc.

18 months of the war:
Emissions – 18.15 $MtCO_2$-eq., including:
17.80 Mt CO_2, 5.0 kt CH_4, and 0.73 kt N_2O.

5. Emissions from forest fires and fires of agricultural lands

A. Forest land
1. Forest land remaining forest land
Controlled burning
Wildfires

Forest fires as a result of shelling:

Kherson, Mykolaiv, Kyiv, Chernihiv, Sumy, Kharkiv, Donetsk, Dnipropetrovsk, and Luhansk regions.

18 months of the war:

Forests fires emissions – 16.68 $MtCO_2$-eq., including:

14.84 Mt CO_2, 44.5 kt CH_4, and 2.46 kt N_2O;

Fires of agricultural lands – 6.44 $MtCO_2$-eq., including:

5.73 Mt CO_2, 17.2 kt CH_4, and 0.95 kt N_2O;

Fires of other nature landscapes – 646 kt CO_2-eq.

6. Emissions from garbage/waste

Waste from houses and commercial structures destroyed by blast waves or damaged by military vehicles:

wooden structures, windows, doors, furniture, household items, personal effects, fences, etc.

Trees were cut down to use the wood to build:

trenches, dugouts, or other shelters.

18 months of the war:

Emissions – 36.8 kt CH_4

Estimated war-related GHG emissions from the first 18 months of the 2022/2023 war in Ukraine

Emissions that originated from the territory of Ukraine but due to their specificity will likely not be covered by Ukraine's next NIRs to the UNFCCC - or they may be reported in a nontransparent way with high uncertainty

Emission sources	Emissions				Relative uncertainty (2δ)
	CO_2, Mt	CH_4, kt	N_2O, kt	Total, $MtCO_2$-eq.	
Use of bombs, missiles, barrel artillery, mines, etc.	0.28	–	–	0.28	+/– 53.9
Use of petroleum products for military actions	28.5	0.25	0.68	28.7	+/– 40.3
Fires of petroleum products at petroleum storage depots	5.4	0.21	0.04	5.43	+/– 20.3
Fires of buildings and infrastructure objects	17.8	5.0	0.73	18.1	+/– 50.5
Forest fires and fires of agricultural fields	21.1	63.3	3.5	23.8	+/– 42.9
Emissions from garbage/waste	–	36.8	–	0.92	+/– 68.8
Total emissions:	**73.1**	**105.6**	**4.96**	**77.2**	**+/– 23.3**

≈ Annual total GHG emissions of Austria, Portugal, or Hungary

Conclusions

“Peace time” vs “War time”

First 18 months of the 2022/2023 war in Ukraine:

Atmosphere

Δ = - 156.7 Mt CO_2-eq.
(18-month period)

Δ = + 77.2 Mt CO_2-eq.
(18-month period)

UNFCCC reporting on GHG emissions
IPCC Guidelines
National Inventory Reports (NIRs)

Unaccounted/ Unreported in NIRs
(not covered by IPCC Guidelines)

Changes in ‘traditional’ emission sectors

Emission sectors that <u>will be covered</u> by NIR, among others:

- Iron and steel production, non-ferrous metals (-56.3 Mt CO_2-eq.)
- Public electricity and heat production (-47.7 Mt CO_2-eq.)
- Road transportation, other transportation (-12.8 Mt CO_2-eq.)
- Chemical industry (-11.6 Mt CO_2-eq.)
- Commercial/residential sector (-10.7 Mt CO_2-eq.)
- Oil and natural gas production (-5.8 Mt CO_2-eq.)

Additional emissions from military actions

Emission processes that <u>will not be covered</u> by NIR:

- Use of bombs, missiles, artillery, mines, etc. (+0.28 Mt CO_2-eq.)
- Use of petroleum products for military actions (+28.7 Mt CO_2-eq.)
- Fires of petroleum storage depots (+5.4 Mt CO_2-eq.)
- Fires of buildings and infrastructure objects (+18.1 Mt CO_2-eq.)
- Forest fires and fires of agricultural lands (+23.8 Mt CO_2-eq.)
- War-related garbage/waste (+0.92 Mt CO_2-eq.)

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

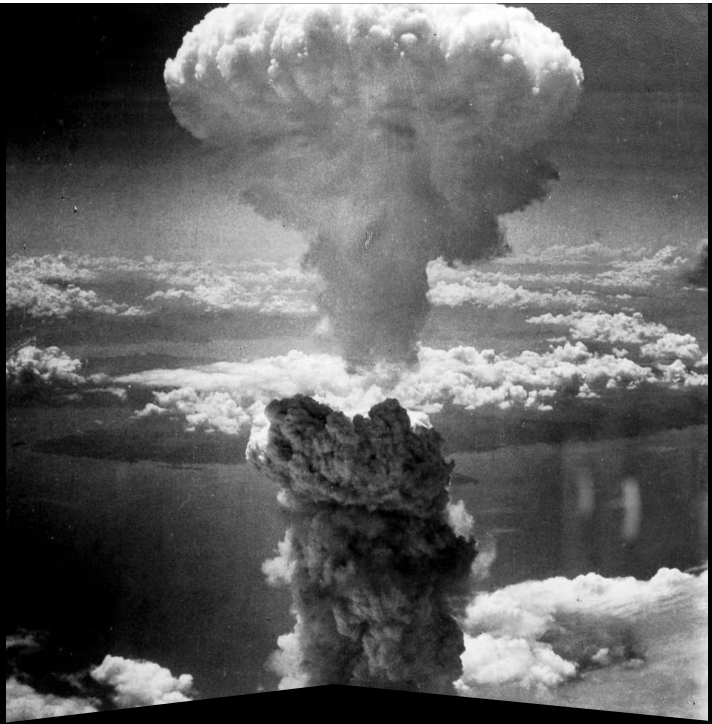
Queen Mary University of London

The Minor Foundation

The environmental footprint of WWII

Military and Conflict Emissions Conference
From understanding to mitigation
Oxford, 26 September 2023

Ladan Abrari
Doctoral Student | Sustainability Science
LUT University, Finland

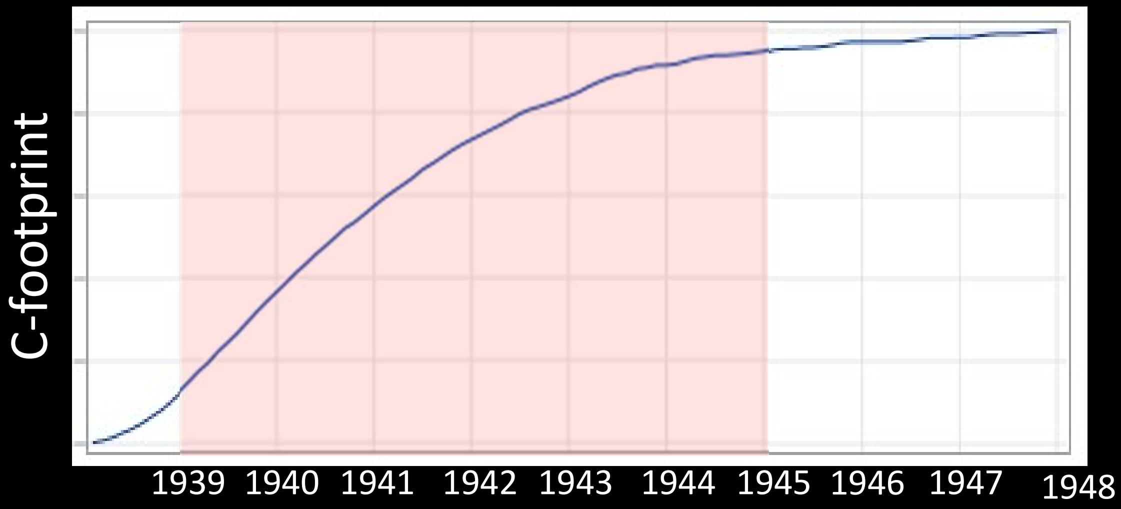




WWII:
The most destructive war

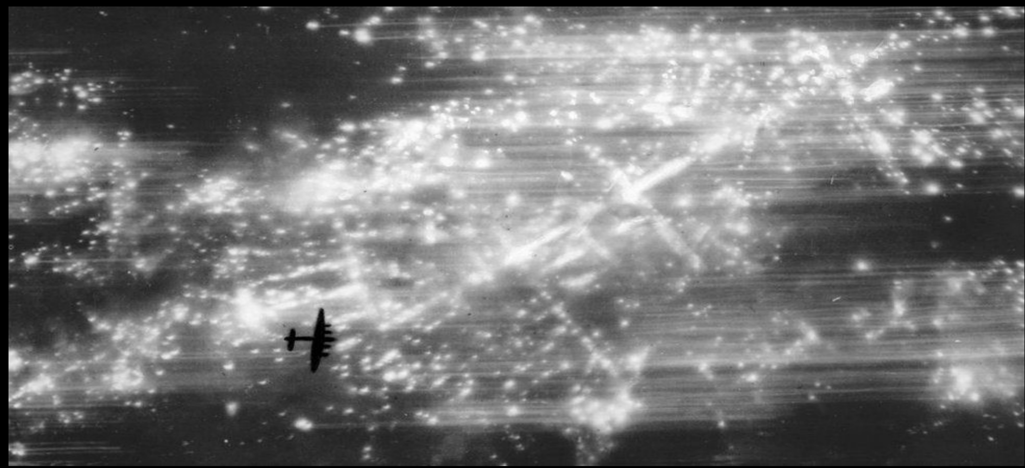
- Deadliest conflict in human history
- Most expensive war
- The most disastrous for the environment

INTRODUCTION

C-footprint = ton CO_2 (eq) emitted



Bombing of Dresden, 1945



From: BBC

C-FOOTPRINT EMISSION ORIGIN

Fuel/ Transport

From: Wikimedia

Fire/ Bombing

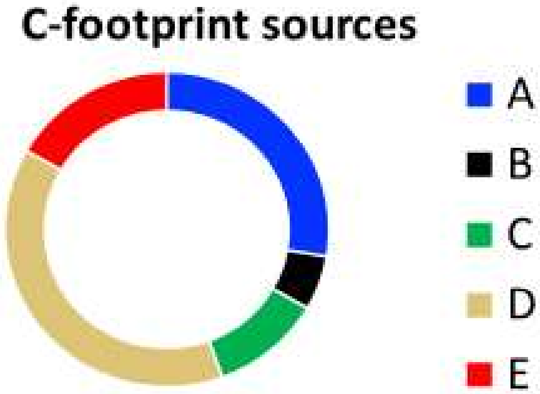
From: History of Yesterday

Resiliency

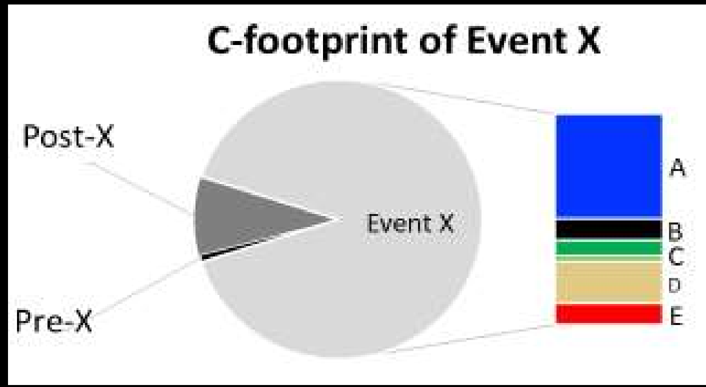
From: Business Insider

Production

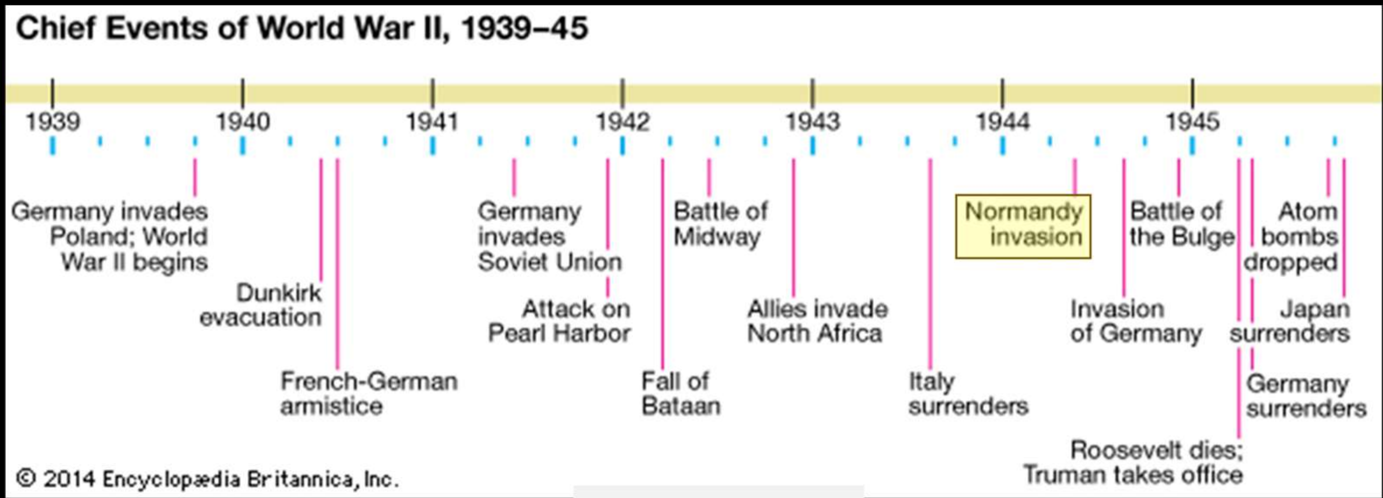
From: War on Rocks



C-FOOTPRINT BASED ON EVENTS



Beginning?



End?

Major events?

RESEARCH METHODOLOGY

Bottom up

INPUT

History

Military

Resource

Civil

Social

PROCESS

Heuristics

OUTPUT

C-footprint

OUTCOMES AND SPECULATIONS

Outcomes

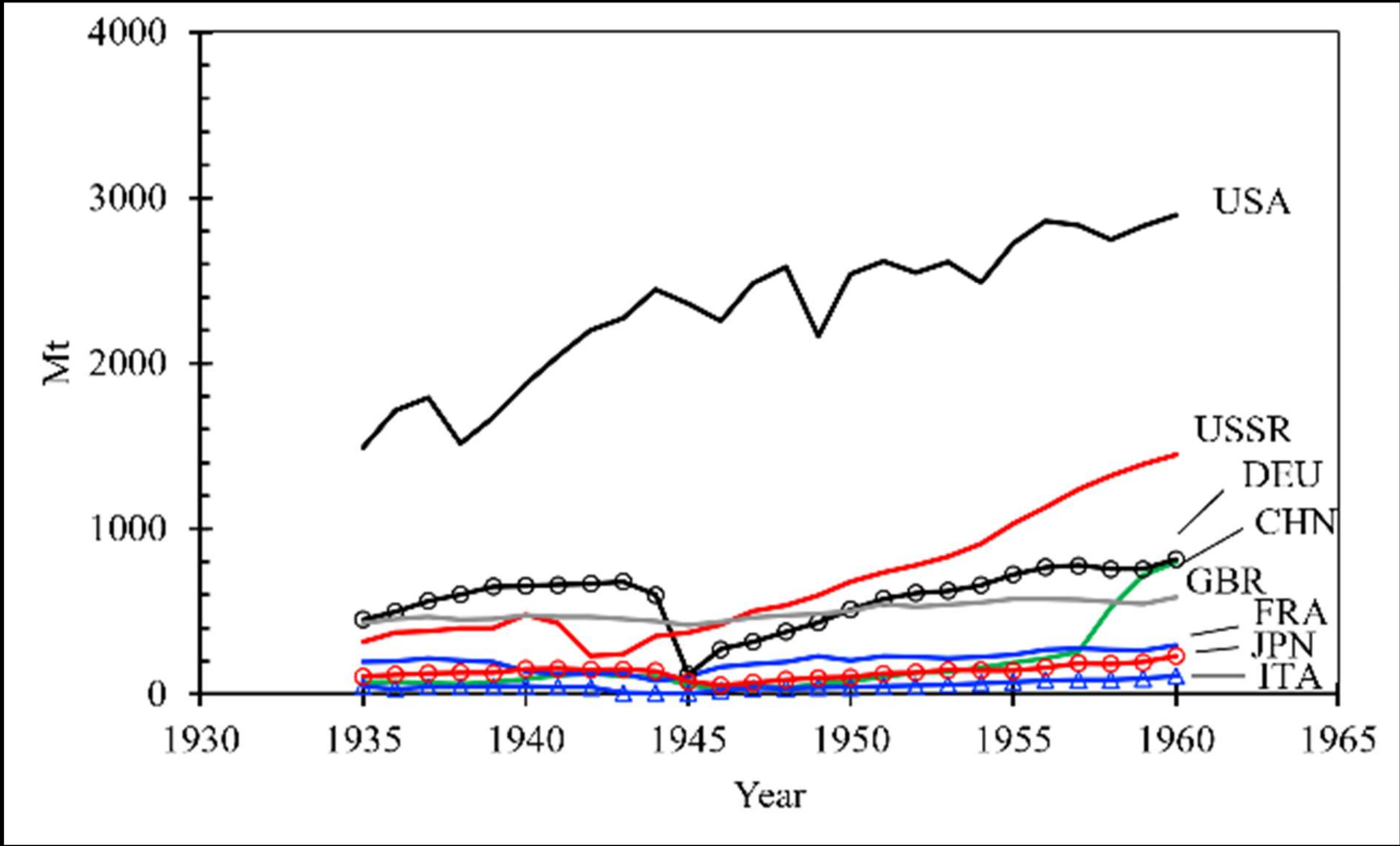
- C-footprint and climate change impact
- Socio-technical transition
- Societal impact
- Databank and seed

Speculations

- Reference value
- WWII stigma and societal impact
- Political implementations near 2050

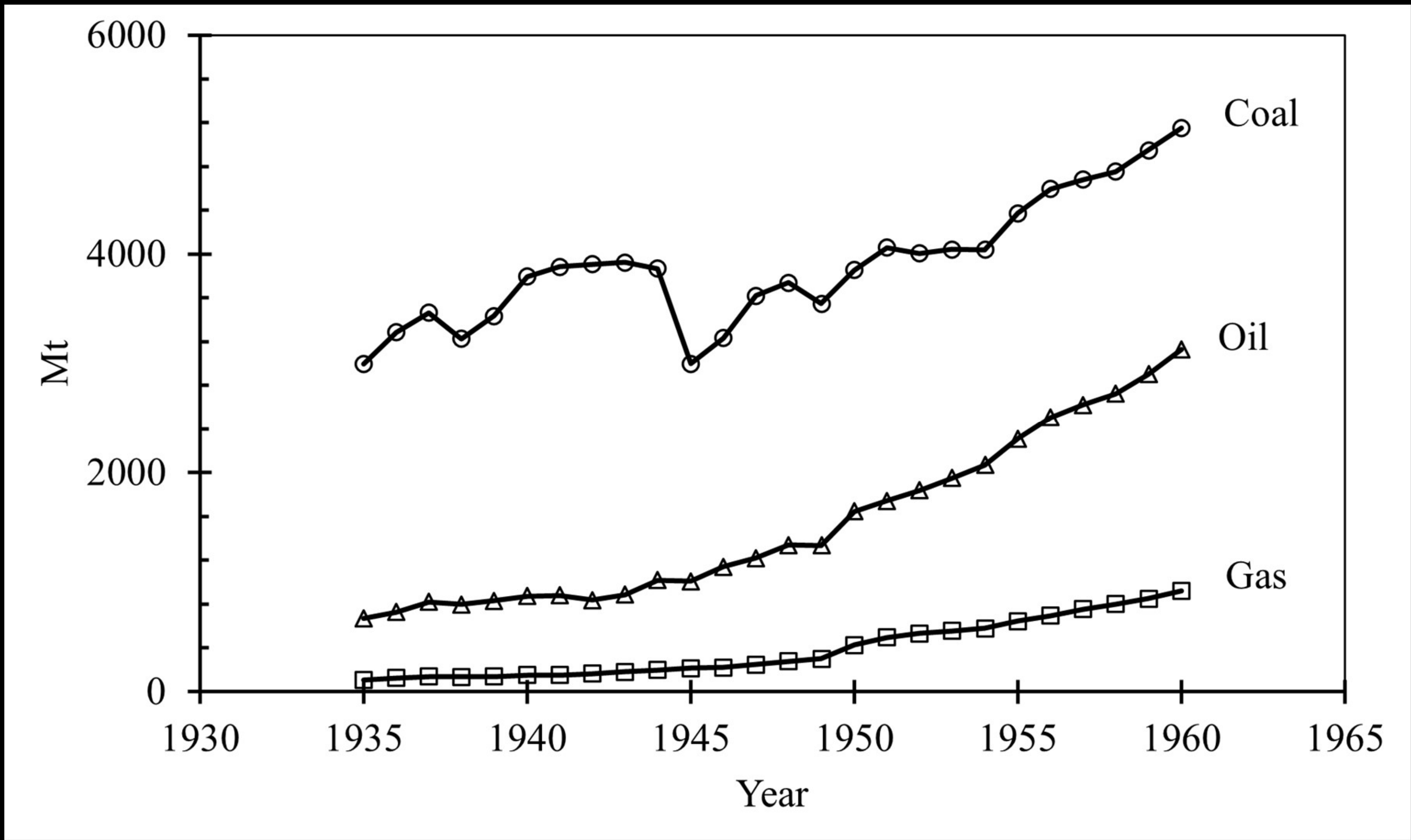

From: Newsonair

ANNUAL CO2 EMISSIONS BY KEY COUNTRIES



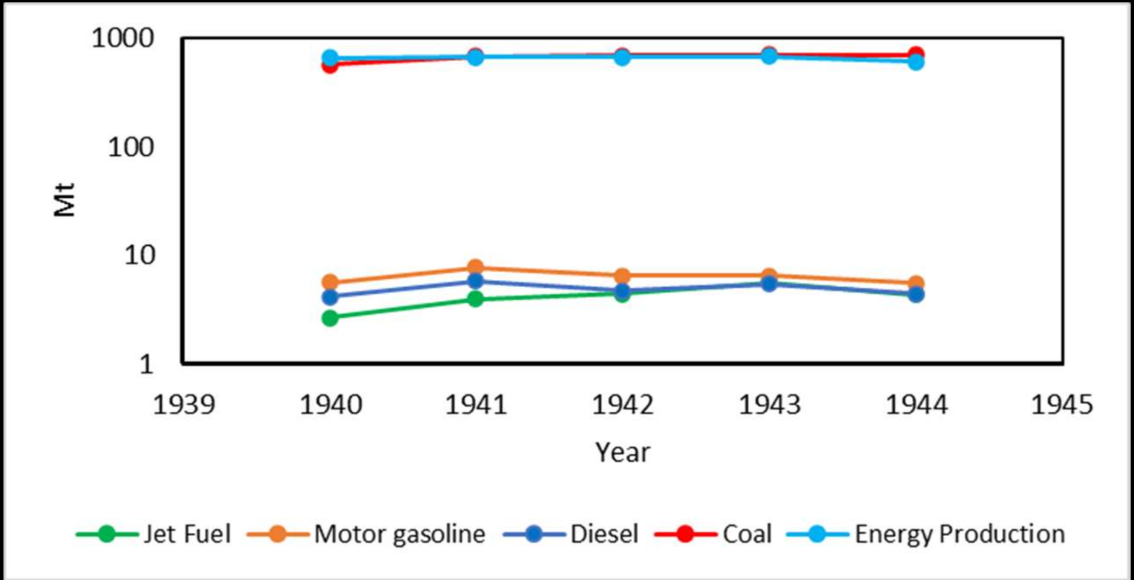
Our World in Data

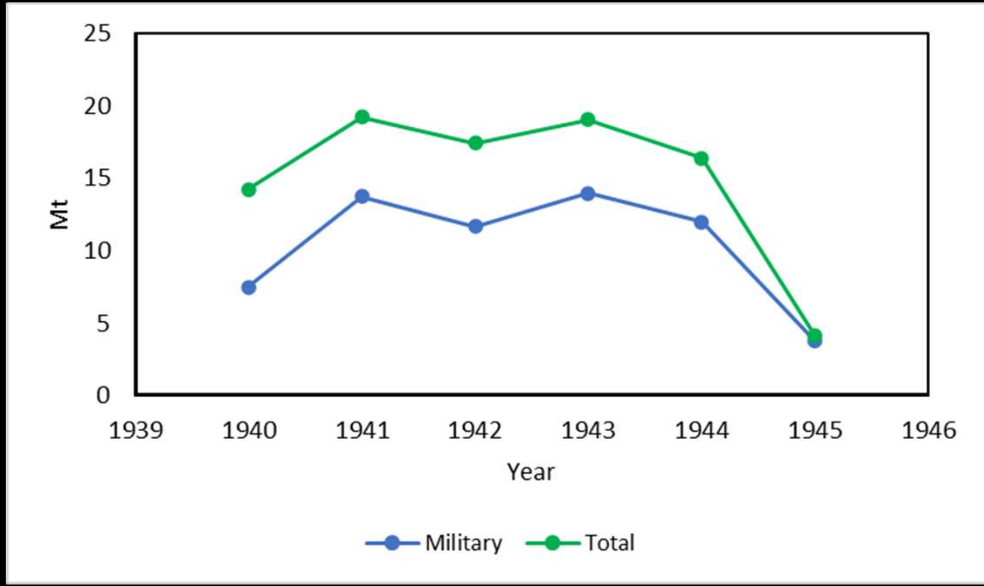
ANNUAL CO2 EMISSIONS BY FUEL



Our World in Data

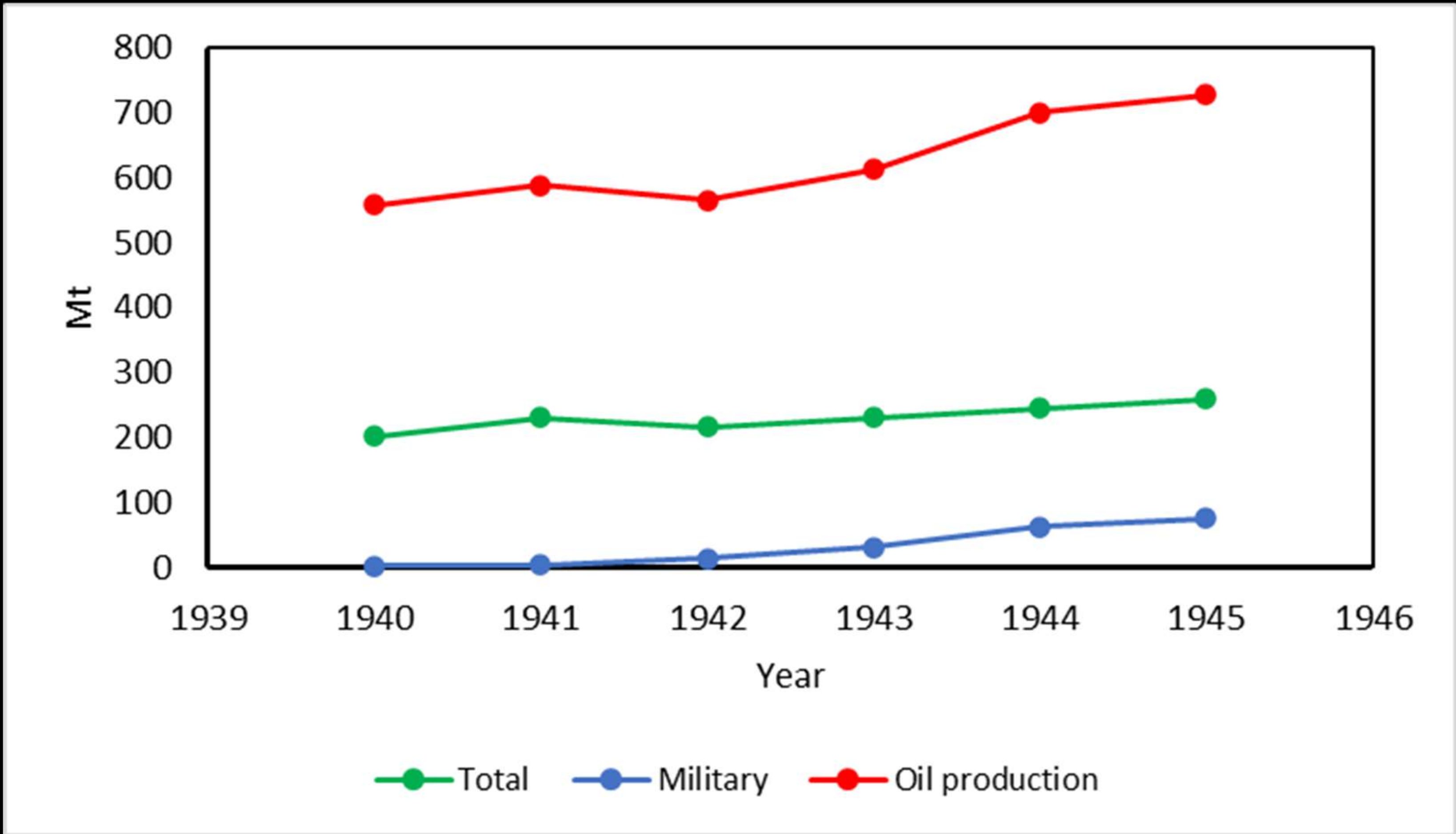
CO2 EMISSIONS BY FUEL CONSUMPTION IN GERMANY



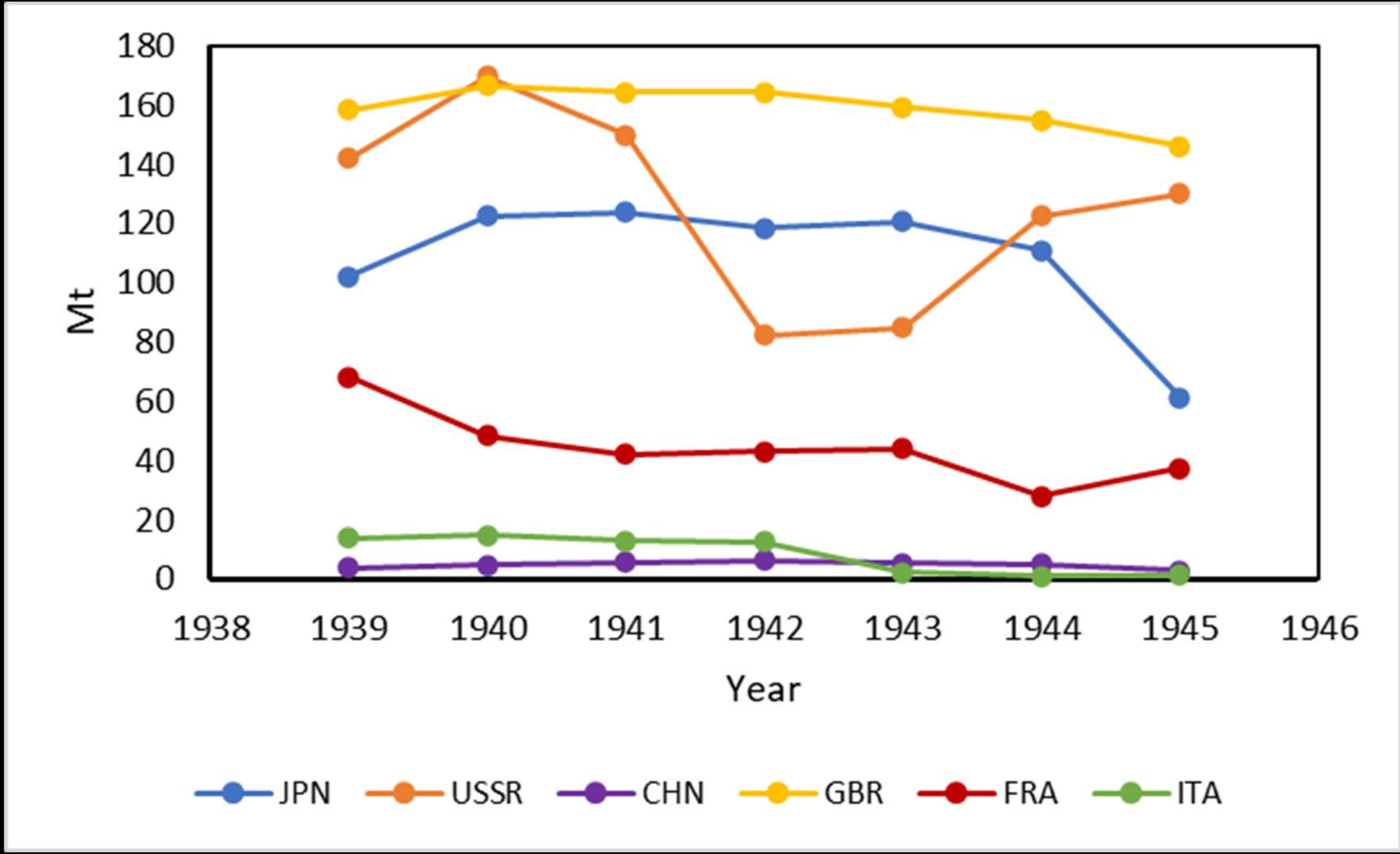


Includes all motor gasoline, diesel fuel, and aviation fuel

CO2 EMISSIONS BY OIL CONSUMPTION IN USA



ROUGH ESTIMATION OF CO2 EMISSIONS BY FUEL CONSUMPTION FOR OTHER KEY COUNTRIES



From: Wikipedia

TRANSITIONS

- Demographic Changes
- Economic Impact
- Industrial and Technological Advancements
- Environmental Aspects

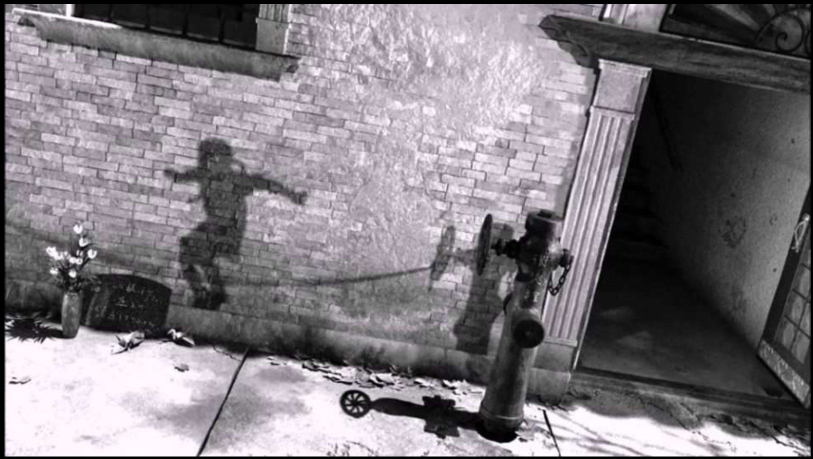
CHALLENGES

Technical

- Database
- Fuzzy boundaries and contingency
- Biases and variability
- Unknowns

Social costs

- Premature death
- Disability
- Mental health issues
- Talents wasted, dispositioned
- Resiliency



From: Global Social Change

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THANK YOU
FOR YOUR ATTENTION!

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