**A response to Bohigas et al**

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This paper is a short response to 'On the Problem of Military GHG Emissions Assessment' by Xavier Bohigas et al.[1]

The Bohigas paper is a combination of literature review, new analysis of arms industry data, and a new estimated range for the global military carbon footprint. While the first two parts include some useful observations, the final estimated range is based on highly implausible assumptions which greatly limit the reliability and usefulness of the estimate.

*Estimated range of global military carbon footprint*

1. The lower end of their estimated range for the global military carbon footprint (0.5% of global emissions) is based on an assumption that the carbon footprint of all national militaries – apart from the USA – is zero (p.15). This assumption is invalid, given that militaries outside the US clearly generate emissions.
2. The upper end of their range (1.3%) is seriously flawed in two ways:
    a. It is based on national data which does not include major components of the military carbon footprint – see (3) below.
    b. It is based on the assumption that greenhouse gas (GHG) emissions intensity – emissions per US$, or '$T_{US}/E_{US}$' using the authors' nomenclature – of all the world's militaries is, on average, the same as the USA. Yet they also say that "fundamentally" there is "greater inefficiency in the use of military budgets in many countries" (p.15). Further evidence to justify the use of a significantly higher figure for emissions intensity is given in (4) below.

    Based on these two factors alone, the upper global estimate could plausibly be considerably higher. Hence it is not an upper estimate.
3. There are significant problems with the basic emissions data that the authors use for their calculations (p.15):
    a. The figure for US military industry emissions (153 MtCO2e) – taken from Crawford (2019)[2] – only includes US activities "related to war" and excludes those related to other military activities (routine patrols, training etc). Crawford's data indicates that, once all military activities are included, the total industrial contribution is approximately 280 MtCO2e,[3] over 80% higher than the figure above.
    b. Crawford also states that the estimate only includes direct emissions from US military industry, i.e. not including their supply chains,[4] so the total scope 3 emissions will be significantly larger than 280 MtCO2e.

[1] Bohigas et al (2026). https://centredelas.org/wp-content/uploads/2026/02/wp2601_Military-emissions-assessment_ENG.pdf

[2] p.20 of: Crawford (2019). https://costsofwar.watson.brown.edu/paper/pentagon-fuel-use-climate-change-and-costs-war

[3] This estimate is for the year 2017 and is taken from Figure 13, p.21, of: Crawford (2019). Op. cit.

[4] p.20 of: Crawford (2019). Op. cit.

c. It is problematic to depend on emissions data from only one nation when making global estimates, even if it is the world's largest military spender. Other studies in this field have routinely used data from more than one nation for the basis of their estimates.

4. The case for the emissions intensity to be significantly higher on average across the globe is reinforced by consideration of the cases of China, Russia, India, and Saudi Arabia – the other four top military spending nations. In 2019 – the year used in this study – these nations were responsible for at least 24% of global military spending.[5] All have high numbers of fossil fuel intensive military craft (especially aircraft, warships, and tanks/ armoured vehicles). All have high numbers of active military personnel – three of them significantly greater than the USA. All are major fossil fuel producers. All have fossil fuel intensive energy systems (including electricity production, transport, and heating/cooling) – significantly more so than the USA. Many other nations with large militaries are also embedded within fossil fuel intensive economies, and so will likely have a significantly higher emissions intensity as well. Indeed, authoritarian nations in general have fewer environmental controls on their militaries, so higher emissions intensities are likely to be common.
5. There is also a significant problem with basing estimates of global military emissions on data on global military expenditure: the spending data is a minimum estimate. Data on major countries such as China and Saudi Arabia (and, since 2022, Russia) are incomplete, while data on other heavily militarised nations such as North Korea are missing entirely. International data on, for example, the numbers of active military personnel are more complete – yet the authors reject this as a basis on which to calculate estimates of global emissions.
6. The authors do not discuss efforts to estimate military carbon footprints using environmentally-extended input output models (EEIOMs). These models are being used successfully in civilian sectors to estimate carbon footprints, and are especially valuable when lifecycle data is of poor quality or incomplete – so could be particularly useful in studies of the military sector. SGR has used some data from these models in all our studies of military carbon footprints, alongside data from other sources.[6] One military – Norway – has recently used an EEIOM to estimate its carbon footprint.[7] Its figures imply that military carbon footprints could be higher than some previous estimates.[8] The paper did not discuss these models or Norway's figures even though they are a critical part of the debate.
7. The authors do not mention the additional heating effect of aviation emissions in the upper atmosphere. This is another significant factor which ought to be included in assessments of military carbon footprints, but rarely is. Inclusion of this factor could significantly increase estimates as aviation emissions would be multiplied by a factor of at least 1.7.[9]
8. The authors do not mention emissions that arise from war-fighting impacts (known as 'scope 3+'), such as damage to carbon reservoirs (e.g. forests, oil depots), refugees movements, or

[5] SIPRI (2020). https://www.sipri.org/sites/default/files/2020-04/fs_2020_04_milex_0_0.pdf

[6] For a list of SGR studies in this field, see: https://www.sgr.org.uk/projects/climate-change-military-main-outputs

[7] FFI (2024). https://www.forsvaret.no/om-forsvaret/miljo/Forsvarssektorens%20klimaregnskap%20for%202023.pdf/_/attachment/inline/c1183920-f674-4c03-bf75-b821a40492ec:b7ad2b1ae98e5290fbe88a59799e40b8be9c5778/Forsvarssektorens%20klimaregnskap%20for%202023.pdf

[8] See pp.13-14 of: Parkinson (2025). https://www.sgr.org.uk/publications/military-spending-rises-and-greenhouse-gas-emissions-what-does-research-say

[9] The factor of 1.7 applies when considering a 100 year time-frame, which is standard practice. For a 20 year timeframe, the factor is 4.0. See Table 5 of: Lee et al. (2021). https://doi.org/10.1016/j.atmosenv.2020.117834

post-war reconstruction. While this is often considered a separate area of study due to the additional complexities, it is a key part of the issue, and the emissions that arise are substantial, so they should at least be mentioned.[10]

9. The authors also make a claim that is difficult to reconcile with their methodology: they say, "Our proposed calculation has the advantage of not using conversion factors, unlike most previous estimates" (p.14). However, the *factor* they use to *convert* the figure for global military spending into a figure for the global military carbon footprint – the emissions intensity, $T_{US}/E_{US}$ – is, by definition, a *conversion factor*. Indeed, other researchers in this field (including SGR) have considered using this option to estimate the global military carbon footprint and have rejected it for all the reasons laid out above.

*Other comments*

10. The analysis using new emissions data from the Spanish arms industry (pp.9-13) is a useful addition to research in this field. It demonstrates some of the pitfalls of using arms industry data as a basis for the calculation of national military carbon footprints. This is why SGR prefers to use data from EEIOMs where possible – even though less of this data is currently available. However, it would have been useful for the authors to emphasise that the upstream supply chain data currently compiled by the arms industry is especially incomplete, meaning that extrapolations based on that data are likely to be particularly low. This is one of the reasons why the estimates of the Spanish military carbon footprint calculated in the report differ as much as they do. Indeed, it is not really surprising – given the lack of good quality data in the area – that estimates for national military carbon footprints which use different methodologies will vary by a factor of two or more.
11. The report recommends greatly increased transparency for the GHG emissions of militaries and military industry in order to both understand the scale of the problem and to help guide efforts to reduce these emissions. We strongly agree.

*About the author*

Dr Stuart Parkinson is Executive Director of SGR. During a career in research and advocacy of over 35 years, he has written extensively on GHG accounting and climate and security issues, including several influential reports on military GHG emissions. He holds a PhD in climate physics and has been an Expert Reviewer for the Intergovernmental Panel on Climate Change.

*About Scientists for Global Responsibility (SGR)*

SGR is UK-based membership organisation which promotes science and technology which contribute to peace, social justice, and environmental sustainability. https://www.sgr.org.uk/

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[10] See, for example: de Klerk et al (2026). https://en.ecoaction.org.ua/climate-damage-4-years-numbers.html