

Supplementary Information: This Supplementary Information has not been peer reviewed. Title: A Systematic Literature Review of Sustainability in the Military

Content

1. Review Protocol 2

1.1 Overview 2

1.1.1 PRISMA Flow Diagram..... 2

1.2 Codebook 3

1.3 PRISMA Checklist 6

1.4 Further Information..... 10

1.4.1 Funding..... 10

2. Sustainability-Military-Matrix 11

3. Descriptive Information about Literature 17

4. Total list of articles included in the review 19

1. Review Protocol

This protocol delineates the decisions and underlying rationales pertaining to the methodology and operationalization of the systematic literature review. Initially, the individual steps of the methodology (identification, screening, analysis) are discussed (Section 1.1). Subsequently, the coding process is addressed in Section 1.2, and the codebook, accompanied by the relevant codes, categories and definitions, is discussed in Section 1.3. Finally, the procedure is explained using the PRISMA checklist (Section 1.4). Further information is provided at the end of the first chapter (Section 1.5).

1.1 Overview

To identify and analyze relevant literature, this study applies the method of systematic literature review (SLR). To enhance methodological rigor and ensure high reporting quality, this study applies the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PRISMA offers a standardized and structured framework that prioritizes transparency and reproducibility by delineating a clear, multi-stage process for the identification, screening, eligibility assessment, and inclusion of studies (Moher et al., 2009). In recognition of recent methodological developments, this study follows the updated 2020 version of the PRISMA guidelines (Page et al., 2021), which provides an even more comprehensive and detailed structure for reporting systematic evidence syntheses.

1.1.1 PRISMA Flow Diagram

The figure illustrates the PRISMA flowchart used to document the systematic review process for identifying, screening, and including relevant literature on sustainability in the armed forces. In the **identification phase**, a total of **3,952** records were retrieved from the Web of Science database using a predefined set of search terms (including variations of “sustainable,” “sustainability,” “climate,” “green,” “armed forces,” and “military”). After removing **3 duplicates**, **3,949** records remained. Subsequently, records not published within the predefined period (2020–2024) were excluded (**–2,301**), followed by the exclusion of records with an inappropriate publication type (**–16**) and low-ranked journals with an SJR < 1 (**–1,192**). This resulted in **440** records entering the screening phase.

In the **screening phase**, all 440 records underwent title screening, during which **374** were excluded. The remaining **66** records proceeded to abstract screening, where **22** additional records were excluded. A total of **44** records were then subjected to full-text assessment, during which **one** article was excluded because it did not sufficiently meet the sustainability or military relevance criteria.

In the **inclusion phase**, **43** studies met all eligibility criteria and were included in the final review. This revised flowchart provides a complete and reproducible overview of all exclusion steps and their corresponding numbers in accordance with PRISMA 2020.

1.2 Codebook

This part of the protocol focuses on the coding scheme that was used for analyzing the literature. The table includes detailed information on several issues: the column 'Coding-Categories' indicates the codenames used in coding the documents. This column also shows for which issues we coded in an open fashion. The column 'Sub-Categories' shows the categories that we defined for the parts of the texts that were coded in an open fashion. These categories were developed iteratively during the cross-case comparison phase of our research. The column 'Definition' indicates how we defined the specific code or category. The column 'Examples' shows an example of the code or category as an illustration for the reader. In the Column 'Additional' we indicate whether the sub-categories were developed after the initial stage of open coding.

Table S1: Codebook

Code category	Code	Sub categories	Definition
Sustainability	Social dimension		The social dimension of sustainability refers to the achievement of defined goals, considering the trade-off between these in all three dimensions. The ecological goals include genetic diversity, resilience and biological productivity.
	Economic dimension		The economic dimension of sustainability refers to the achievement of defined goals, considering the trade-off between these in all three dimensions. The economic goals include satisfying basic needs (reducing poverty), increasing equity and increasing the number of useful goods and services.
	Ecologic dimension		The ecological dimension of sustainability refers to the achievement of defined goals, considering the trade-off between these in all three dimensions. The ecologic goals include genetic diversity, resilience and biological productivity.
Fundamental application field	Operation		This refers to the basic operation of armed forces.
	Infrastructure		This includes military infrastructure such as facilities (e.g. barracks) or logistics chains and non-military infrastructure that is used for military purposes (e.g. roads, railways).
	Logistics		Military logistics is the planning and execution of the supply, transportation and maintenance of armed forces. It therefore encompasses all traditional areas of logistics.

Military	Research and Development		This includes research and development activities of armed forces with the aim of becoming more sustainable, considering the sustainability dimensions of economy, ecology and social issues. This can relate to different subject areas (such as energy) and scenarios, including basic operations, military or civilian missions, exercises or even war.
	Procurement		This includes the procurement of military and non-military goods.
	Instruments of sustainability	Critical success factors	This includes the perspective between the armed forces and sustainability regarding the objectives. This means 1) alignment of objectives (win-win situation), 2) neutrality of objectives and 3) conflict of objectives.
		Technologies	This includes digital and non-digital technologies that are used in a military context and make a positive contribution to sustainability or its dimensions.
		Military application field	The area of application can be in the back end (behind the front line) or in the front end, e.g. at the front or front line, in combat operations, in the troops or in technology.
	Military situation		The military situation includes different situations in which armed forces must operate. These includes peace, crises or war.

1.3 PRISMA Checklist

The section contains the PRISMA Checklist from Page et al. (2020) that includes 27 items.

Table S2: PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Chapter 1
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Chapter 1
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Subchapter 2.1
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Subchapter 2.1
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Subchapter 2.1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Subchapter 2.1
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Subchapter 2.1
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all	Subchapter 2.1

		measures, time points, analyses), and if not, the methods used to decide which results to collect.	
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Subchapter 2.1
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Subchapter 2.1
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Subchapter 2.1
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Subchapter 2.1
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Subchapter 2.1
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Subchapter 2.1
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Subchapter 2.1
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Subchapter 2.1
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Subchapter 2.1
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Subchapter 2.1
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Subchapter 2.2
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Chapter 3
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Chapter 3

Study characteristics	17	Cite each included study and present its characteristics.	Subchapter 4.1, 4.2, 4.3
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Subchapter 4.1, 4.2, 4.3
Results of individuals studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Subchapter 4.1, 4.2, 4.3
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Subchapter 4.1, 4.2, 4.3
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Subchapter 4.1, 4.2, 4.3
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Subchapter 4.1, 4.2, 4.3
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Subchapter 4.1, 4.2, 4.3
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	-
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Chapter 5
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Chapter 5
	23b	Discuss any limitations of the evidence included in the review.	Chapter 5
	23c	Discuss any limitations of the review processes used.	Chapter 5
	23d	Discuss implications of the results for practice, policy, and future research.	Chapter 5
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	The registration process has not been initiated.
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	The procedure is described in Chapter 2, Subchapter 2.1, and a PRISMA flow

			chart has been created to illustrate it.
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	No changes.
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	No external funding.
Competing interests	26	Declare any competing interests of review authors.	The authors report there are no competing interests to declare.
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	The supplementary materials provide additional information and will be freely accessible after publication

1.4 Further Information

The following sections contain further information to funding and authors.

1.4.1 Funding

No Funding

2. Sustainability-Military-Matrix

Based on the analysis, 39 topics were identified and assessed for their strategic relevance. Each topic was rated—based on the authors' subjective judgment—according to its estimated high or low effect on military capability and sustainability. These ratings form the basis of the "sustainability-military matrix", which is structured along two axes: "sustainability effect" and "military capability effect", each divided into "low" and "high".

This results in four quadrants: Prioritization Strategy (Sustainability driven implementation), Prioritization Strategy (Military capability driven implementation), Exclusion Strategy, and Implementation Strategy. These quadrants enable a structured and comparative evaluation of the identified topics. The following applies:

- Topics assigned to this quadrant have a high sustainability effect but a low military capability effect. From a sustainability perspective, these topics should be prioritized.
- Topics assigned to this quadrant have a high military capability effect but a low sustainability effect. From a military perspective, these topics should be prioritized.
- Topics in this quadrant exhibit both low military capability and low sustainability effects. As such, their exclusion from further strategic consideration is recommended.
- Topics in this quadrant exhibit both high military capability and high sustainability effects. As such, their implementation is recommended.

As part of the initial assessment, 14 out of the 39 identified topics were assigned to the Implementation Strategy quadrant. This corresponds to more than 35% and may serve as an initial indication of the potential for targeted implementation and strategic development within the examined context. The selected topics cover a broad spectrum of sustainability dimensions (economic and ecological), academic disciplines (e.g., logistics, technology, innovation, infrastructure, procurement), and levels of action (strategic and operational).

The following table presents the classification of the 39 topics identified through the conducted analysis, along with their allocation to the four quadrants of the

Sustainability-Military-Matrix. Of these 39 topics, 14 are assigned to the implementation strategy, 9 to Prioritization strategy from both perspectives, and 7 to the exclusion strategy.

Table S3. Evaluation of the identified topics and their classification along the axes of the Sustainability-Military-Matrix

No.	Topic	Sustainability effect		Military capability effect		Strategy
		Low	High	Low	High	
1	AM		✓		✓	Implementation strategy
2	Renewable Energy		✓		✓	Implementation strategy
3	Sustainability Metrics		✓		✓	Implementation strategy
4	Biotechnological Innovation		✓		✓	Implementation strategy
5	Ecosystem Protection		✓		✓	Implementation strategy
6	Climate-Resilient Infrastructure		✓		✓	Implementation strategy
7	Sustainable Logistics		✓		✓	Implementation strategy
8	Hydrogen Propulsion		✓		✓	Implementation strategy
9	Strategic Procurement		✓		✓	Implementation strategy
10	Climate Risk Assessment		✓		✓	Implementation strategy
11	Renewable Infrastructure		✓		✓	Implementation strategy
12	Bioenergy Systems		✓		✓	Implementation strategy
13	Defence R&D		✓		✓	Implementation strategy
14	Mission-Aligned Adaption		✓		✓	Implementation strategy

No.	Topic	Sustainability effect		Military capability effect		Strategy
		Low	High	Low	High	
15	Species Protection		✓	✓		Prioritization strategy (Sustainability driven implementation)
16	Reforestation Projects		✓	✓		Prioritization strategy (Sustainability driven implementation)
17	Ecosystem Health Goals		✓	✓		Prioritization strategy (Sustainability driven implementation)
18	Biopolymer Materials		✓	✓		Prioritization strategy (Sustainability driven implementation)
19	Cement Substitutes		✓	✓		Prioritization strategy (Sustainability driven implementation)
20	Civilian Tech Transfer		✓	✓		Prioritization strategy (Sustainability driven implementation)
21	Earth Force Vision		✓	✓		Prioritization strategy (Sustainability driven implementation)
22	Ethical Governance		✓	✓		Prioritization strategy (Sustainability driven implementation)
23	Indigenous Rights Conflicts		✓	✓		Prioritization strategy (Sustainability driven implementation)
24	Footprint Reduction	✓			✓	Prioritization strategy (Military capability driven implementation)
25	Biodiversity Reform	✓			✓	Prioritization strategy (Military capability driven implementation)

No.	Topic	Sustainability effect		Military capability effect		Strategy
		Low	High	Low	High	
						driven implementation)
26	Water Management	✓			✓	Prioritization strategy (Military capability driven implementation)
27	On-Site Manufacturing	✓			✓	Prioritization strategy (Military capability driven implementation)
28	Digital Logistics	✓			✓	Prioritization strategy (Military capability driven implementation)
29	Fuel Efficiency Planning	✓			✓	Prioritization strategy (Military capability driven implementation)
30	AM Logistics	✓			✓	Prioritization strategy (Military capability driven implementation)
31	Battery Vehicles	✓			✓	Prioritization strategy (Military capability driven implementation)
32	Training Technologies	✓			✓	Prioritization strategy (Military capability driven implementation)
33	Space Militarization	✓		✓		Exclusion strategy

No.	Topic	Sustainability effect		Military capability effect		Strategy
		Low	High	Low	High	
34	Munitions Pollution	✓		✓		Exclusion strategy
35	Unregulated Emissions	✓		✓		Exclusion strategy
36	Resource Overuse	✓		✓		Exclusion strategy
37	Arms Export Impact	✓		✓		Exclusion strategy
38	Short-Term Planning	✓		✓		Exclusion strategy
39	Environment Oversight	✓		✓		Exclusion strategy

3. Descriptive Information about Literature

The following table provides additional descriptive information about the reviewed articles.

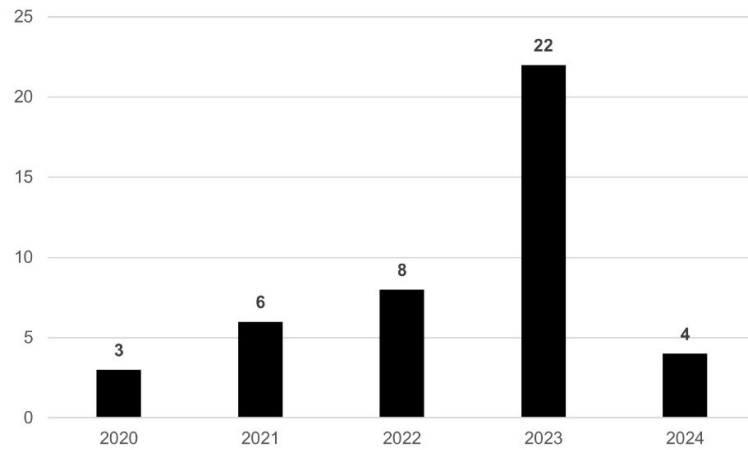


Fig. S1: Publications per year.

Table S4. Number of publications per Journal

Journal	No. of publications
Environmental Science and Pollution Research	4
Journal of Cleaner Production	4
International Journal of Hydrogen Energy	3
Earth System Governance	2
Energy	2
Sociology Compass	2
Science of the Total Environment	2
Review of International Political Economy	1
Management of Environmental Quality	1
Current Opinion in Environmental Sustainability	1
Cities	1
Antipode	1
Biotechnology Advances	1
Energy Research and Social Science	1
Environmental Politics	1
International Affairs	1
International Studies Review	1
Journal of Applied Physiology	1
Energy Strategy Reviews	1
Transactions of the Institute of British Geographers	1
Climate Risk Management	1
Global Environmental Change	1
American Sociological Review	1
Political Geography	1
Climate Services	1
British Journal of Criminology	1
Journal of Materials Research and Technology	1
Environmental Sciences Europe	1
Composites Part C: Open Access	1
International Studies Quarterly	1
Fuel	1
Σ	43

4. Total list of articles included in the review

The following table presents the literature identified and analyzed using the PRISMA systematic review method. In addition to the relevant sources, it includes information on the theoretical framework, methodological approach, geographical focus, and number of subjects examined

Table S5. Total list of articles included in the review

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
1	Soder, R.	Climate change, security and military organizations: Changing notions in the Swedish armed forces	Earth System Governance	2023	Securitization Framework	Qualitative case study design with the following methods: • Analysis of documents • Coding & Analysis with MAXQDA • Semi-structured Interviews	Sweden	35 sources

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
2	den Boer, J., Lambrechts, W. & Krikke, H.	Additive manufacturing in military and humanitarian missions: Advantages and challenges in the spare parts supply chain	Journal of Cleaner Production	2020	Theory elaboration is applied using the framework	Mixed qualitative methodology: • Systematic literature review • Desk research of internal documents and case studies • Semi-structured interviews with 10 stakeholders • Qualitative coding using NVivo (open, axial, and selective coding)	Royal Netherlands Army and its missions in Afghanistan and Mali	10 interview respondents

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
3	Albert, M. J.	The global politics of the renewable energy transition and the non-substitutability hypothesis: towards a 'great transformation'?	Review of International Political Economy	2022	• Critical International Political Economy (IPE) • Non-Substitutability Hypothesis (NSH)	The work is conceptual and theoretical. It does not use empirical or quantitative methods but instead: • Synthesize existing literature from IPE, energy studies, and ecological economics. • Develop scenario-based analysis to explore future pathways of global politics under the NSH.	• G7 countries • China • Global South (especially fossil fuel-dependent economies) • US military (as a case for energy-intensive security structures)	
4	Arif, M.	Sustainable management of national resources through implementation of balanced scorecard	Management of Environmental Quality	2021	• Resource-Based Theory (RBT) • Balanced Scorecard (BSC)	Quantitative research design: • A structured questionnaire • Stratified random sampling • Data were analyzed using SPSS, including reliability testing	Pakistan, specifically on the Pakistan defense services (Army, Navy, Air Force)	304 officers

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
5	Francisco, M.	Artificial intelligence for environmental security: national, international, human and ecological perspectives	Current Opinion in Environmental Sustainability	2023	• Constructivist understanding of security • Framework of environmental security discourses	Qualitative literature review	Global scope	25 academic publications as its main corpus.
6	Ural, E. & Severcan, Y. C.	Assessing user preferences regarding military site regeneration: The case of the Fourth Corps Command in Ankara	Cities	2022	Urban regeneration theory	Quantitative survey method: • structured questionnaire • Analysis of Data using SPSS • Descriptive statistics Paired and unpaired t-tests	Turkey, specifically the Mamak Fourth Corps Command military site in Ankara	300 individuals
7	Sparrevik, M. & Utstol, S.	Assessing life cycle greenhouse gas emissions in the Norwegian defence sector for climate change mitigation	Journal of Cleaner Production	2020	Organizational Life Cycle Assessment (O-LCA) framework, developed by UNEP/SETAC	Hybrid LCA approach	Norway	Norwegian defense sector as a single organizational unit

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
8	Zhu, W., Mehmood, U., Alnafrh, I., Abou H. M. & Dagestani, A. A.	How military spending, economic growth, and renewable energy impacts ecological footprints in Next Eleven nations	Environmental Science and Pollution Research	2023	• Treadmill of Destruction Hypothesis • Environmental Kuznets Curve • Panel Cointegration Theory	Econometric approach: • Cross-Section Autoregressive Distributed Lag (CS-ARDL) Model • Panel Unit Root Tests (CADF, CIPS) • Slope Homogeneity Test: To assess coefficient consistency. • Westerlund Cointegration Test • Augmented Mean Group (AMG) Estimator	Next Eleven (N-11) countries, which include: Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, Philippines, South Korea, Turkey, and Vietnam.	11 countries over a 32-year period (1990–2022)
9	Neimark, B., Belcher, O., Ashworth, K. & Larbi, R.	Concrete Impacts: Blast Walls, Wartime Emissions, and the US Occupation of Iraq	Antipode	2024	• Geopolitical Ecology • Life Cycle Assessment (LCA)	• LCA • Monte Carlo simulation • GIS and image analysis tools • Scenario modeling	Baghdad, Iraq, during the US military occupation (2003 to 2008)	412 km of blast walls, equivalent to 164,648 concrete wall sections

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
10	Abdalla, M. S. M., Balli, O., Adali, O., Korba, P. & Kale, U.	Thermodynamic, sustainability, environmental and damage cost analyses of jet fuel starter gas turbine engine	Energy	2023	• Thermodynamic theory • Exergy analysis • Sustainability theory • Environmental impact and damage cost theory	• Experimental testing of a Jet Fuel Starter Gas Turbine Engine (JFS-GTE) under on-design and off-design conditions • Quantitative analysis	Turkey	A single Jet Fuel Starter Gas Turbine Engine (JFS-GTE) was analyzed under two operational modes: On-design mode Off-design mode
11	Payne, C. R. & Swed, O.	Disentangling the US military's climate change paradox: An institutional approach	Sociology Compass	2023	• Institutional Logics Theory • Treadmill of Destruction (Environmental Sociology) • Organizational Sociology	• Literature Review • Document Analysis • Theoretical Interpretation	• USA: Focus on U.S. military and its global operations • Global: Includes analysis of U.S. military bases and activities worldwide	U.S. military as unit of analysis

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
12	Jayaram, D. & Brisbois, M. C.	Aiding or undermining? The military as an emergent actor in global climate governance	Earth System Governance	2021	• Earth System Governance Framework • Securitization Theory • Critical Security Studies	• Conceptual and theoretical analysis • Empirical examples • Interdisciplinary synthesis	Global scope, with specific examples from: • United States • United Kingdom • India • Indonesia • Brazil • Myanmar • Sahel region (Africa)	• Not a quantitative study • Multiple qualitative case examples
13	Mori, M., Baskovic, U. Z., Stropnik, R., Lotric, A., Katrasnik, T., Sipek, R., Lipar, J., Lesar, Z. & Drobnic, B.	Green energy hubs for the military that can also support the civilian mobility sector with green hydrogen	International Journal of Hydrogen Energy	2023	• Energy Hub Theory • Sector Coupling Concept • Carbon Footprint and Net Present Value (NPV) Analysis • Renewable Energy Systems Optimization	• Mathematical modeling • Parametric analysis • Environmental assessment • Economic analysis • Scenario modeling	• Slovenia	• One primary case study • Multiple parametric scenarios

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
14	Krebs, R., Farrington, K. E., Johnson, G. R., Luckarift, H. R., Diltz, R. A. & Owens, J. R.	Biotechnology to reduce logistics burden and promote environmental stewardship for Air Force civil engineering requirements	Biotechnology Advances	2023	• Biomineralization and Biocementation Theory • Biotechnical Stabilization • Waste-to-Energy and Anaerobic Digestion Theory • Phytoremediation Theory • Bioelectrochemical Systems	• Literature review and synthesis • Field trials and pilot studies • Comparative analysis	• USA	Not quantified as discrete statistical units
15	Chang, S., Chen, B. & Song, Y.	Militarization, renewable energy utilization, and ecological footprints: Evidence from RCEP economies	Journal of Cleaner Production	2023	• Treadmill of Destruction Theory • EKC • Ecological Footprint Framework	• Panel econometric analysis	15 RCEP countries: • Australia, • Brunei, • Cambodia, • China, • Indonesia, • Japan, • Laos, • Malaysia, • Myanmar, • New Zealand, • Philippines, • Singapore, • South Korea, • Thailand, • Vietnam	• 15 countries • Total observations: 435

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
16	Katalenich, S. M. & Jacobson, M. Z.	Toward battery electric and hydrogen fuel cell military vehicles for land, air, and sea	Energy	2022	• Whole-system design optimization • Efficiency and sustainability modeling • Technological tipping point analysis	• Quantitative modeling and simulation • Environmental impact estimation	• USA	Nine vehicle categories
17	Isiksal, A. Z.	Testing the effect of sustainable energy and military expenses on environmental degradation: evidence from the states with the highest military expenses	Environmental Science and Pollution Research	2021	• EKC-Hypothesis • Treadmill of Destruction Theory	• Panel econometric techniques	Ten countries with the highest military expenditures: • Saudi Arabia • Israel • Russia • USA • South Korea • India • France • Australia • China • United Kingdom	10 countries
18	Sravan, Ch. & Mishra, P. P.	When national defence meets decarbonization: Arming India's just transition with military assistance	Energy Research and Social Science	2023	• Just Transition Theory • Treadmill of Destruction Theory • Degrowth Theory	• Conceptual and theoretical analysis • Case-based discussion	• India (primary focus) • References to United States, Portugal, and global military practices	• Multiple initiatives and institutions (e.g., Indian Army, Navy, Air Force, DRDO)

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
19	Pata, U. K., Destek, M. A., Manga, M. & Cengiz, O.	Militarization of NATO countries sparks climate change? Investigating the moderating role of technological progress and financial development	Journal of Cleaner Production	2023	• EKC-Hypothesis • Treadmill of Destruction Theory	• Panel data econometrics	• 15 NATO member countries	• 15 countries • Total observations: 420
20	Bell, K., Price, V., McLoughlin, K. & Kojola, E.	The necessity of a transformational approach to just transition: defence worker views on decarbonisation, diversification and sustainability	Environmental Politics	2024	• Gramscian theory • Neo-Gramscian perspectives • Transformative Just Transition	• Semi-structured interviews • Focus groups • Document analysis and literature review	• United Kingdom • USA	• 58 individual interviews • 2 focus groups with 18 organizational representatives
21	Depledge, D.	Low-carbon warfare: climate change, net zero and military operations	International Affairs	2023	• Critical security studies • Environmental security • Organizational adaptation theory	Synthesize existing literature, policy documents, and strategic reports	Western countries, especially: • United Kingdom • USA • European Union • NATO • References to China and India	Discussion of multiple national militaries and institutions (e.g., UK MoD, US DoD, NATO, PLA) in a qualitative and illustrative manner

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
22	Vogler, A.	Tracking Climate Securitization: Framings of Climate Security by Civil and Defense Ministries	International Studies Review	2023	• Organizational theory • Securitization theory • Framing theory	• Comparative content analysis • Quantitative coding • Statistical comparison	• 39 countries • These countries span Europe, Asia, Oceania, and the Americas,	Total units analyzed: 120 documents
23	Moran, D. S., DeGroot, D. W., Potter, A. W. & Charkoudian, N.	Beating the heat: military training and operations in the era of global warming	Journal of Applied Physiology	2023	• Integrative physiology • Environmental health and climate science • Risk assessment and mitigation theory	• Literature review • Analysis of historical climate and heat illness data • Modeling and simulation • Evaluation of countermeasures	• USA • Israel	• Three U.S. Army training installations • 745 cases of exertional heat stroke (EHS) • Over 4,500 service members
24	Sovacool, B. K.; Baum, C. & Low, S.	The next climate war? Statecraft, security, and weaponization in the geopolitics of a low-carbon future	Energy Strategy Reviews	2023	• Geopolitical theory • Security and conflict theory • Political ecology and international relations • Novel conceptual framework	• Qualitative expert interviews • Conceptual framework development • Portfolio analysis	Global in scope, considering • Major powers like the USA, China, Russia, India • Vulnerable regions such as the Arctic, South China Sea, and Small Island Developing States	• 20 climate technologies • 125 expert interviews from 104 organizations across 21 countries

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
25	Belcher, O., Bigger, P., Neimark, B. & Kennelly, C.	Hidden carbon costs of the everywhere war: Logistics, geopolitical ecology, and the carbon boot-print of the US military	Transactions of the Institute of British Geographers	2020	• Geopolitical Ecology • Critical Logistics and Supply Chain Studies • Path Dependency Theory	• Qualitative document analysis • Quantitative analysis • Comparative emissions analysis	Global operations of the U.S. military	U.S. military fuel purchases and emissions from fiscal years 2013 to 2017
26	Smith, C. B., Acevedo-Acevedo, D., Martinez-Guerra, E., Medina, V. F., Duczynski, M. P., Wolters, S. R., Garfinkle, N. W., Melendez, L. & Feliciano, L. I	Developing water resiliency solutions at military installations	Climate Risk Management	2022	• Resilience theory • Sustainability and risk management frameworks • Multi-Criteria Decision Analysis (MCDA)	• A structured five-step planning process • Quantitative assessments • Development and evaluation of 167 COAs • Water Use Intensity (WUI) modeling	U.S. military installations, specifically those managed by the U.S. Army	• 35 completed IEWPs • 167 COAs • 9 U.S. Army installations • Over 100,000 facility-months
27	Burnett, M. & Mach, K. J.	A precariously unprepared Pentagon? Climate security beliefs and decision-making in the US military	Global Environmental Change	2021	• Climate security theory • Decision-making theory • Co-production theory	• Qualitative content analysis • Semi-structured interviews • Grounded theory coding	• USA, specifically the U.S. DoD	• 80 national security documents • 42 interviews

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28	Almeida, J., Monahan, A., Dionisio, J., Delgado, F. & Magro, C.	Sustainability assessment of wastewater reuse in a Portuguese military airbase	Science of the Total Environment	2022	• Sustainability assessment theory • Environmental auditing frameworks • Wastewater treatment theory	• Case study analysis • Empirical data collection • Comparative analysis • Cost-benefit analysis • Technology screening	Portugal, specifically at Monte Real Air Force Base	One wastewater treatment plant (WWTP) at a single military airbase
29	Balli, O. & Caliskan, H.	Energy, exergy, environmental and sustainability assessments of jet and hydrogen fueled military turbojet engine	International Journal of Hydrogen Energy	2022	• Thermodynamic theory • Exergy analysis • Sustainability assessment theory • Environmental impact assessment	• Comparative simulation modeling • Energy and exergy analysis • Environmental and sustainability metrics • Parametric calculations	Not region- specific in terms of environmental impact but is conducted in Turkey	• Focus on one military turbojet engine model (J79-GE-17) • Two fuel scenarios are compared: JP-8 and hydrogen

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30	Jorgenson, A. K., Clark, B., Thombs, R. P., Kentor, J., Givens, J. E.; Huang, X., El Tinay, H., Auerbach, D. & Mahutga, M. C.	Guns versus Climate: How Militarization Amplifies the Effect of Economic Growth on Carbon Emissions	American Sociological Review	2023	• Treadmill of Production and Treadmill of Destruction • Metabolic Rift Theory • Ecologically Unequal Exchange Theory • Historical Sociology and Political-Economic Sociology	• Longitudinal Panel Data Analysis • Fixed Effects Regression Models • Moderation Analysis • Robustness Checks and Sensitivity Analyses • Counterfactual Analysis	106 countries worldwide, Countries range from high-income to low-income, including examples from Africa, Asia, Europe, the Americas, and Oceania	2,563 annual observations

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31	Vogler, A.	Barking up the tree wrongly? How national security strategies frame climate and other environmental change as security issues	Political Geography	2023	• Framing Theory • Securitization Theory • Environmental and Climate Security • Planetary Boundaries Framework (Steffen et al., 2015)	• Inductive Content Analysis • Comparative Analysis • Temporal and Regional Analysis • Quantitative Coding	93 countries worldwide, including regions such as: • Western and Eastern Europe • North and South America • Sub-Saharan Africa • Southeast and East Asia • Australasia • Central America and the Caribbean • Western and Southern Asia	310 National Security Strategy Documents (NSSDs), published by 93 countries

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32	Oshiro, A.	From footprint to relationships: Impacts of US military base on Okinawa	Sociology Compass	2024	• Footprint Perspective: Focuses on the quantifiable environmental impacts of military activities • Relational Perspective: Drawn from Indigenous studies and postcolonial sociology	• Theoretical synthesis • Literature review • Positionality-based analysis	• Japan (especially Okinawa) • Pacific regions affected by militarization: Guam, South Korea, Hawaii, American Samoa, Philippines, Northern Mariana Islands, Marshall Islands	• Multiple cases of environmental impact in Okinawa • Various communities and movements • Comparative references
33	Garfin, G., Falk, D. A., O'Connor, C. D., Jacobs, K. S., Raphael D., Haverland, A. C., Haworth, A.; Baglee, A., Weiss, J., Overpeck, J. & Zuniga-Teran, A. A.	A new mission: Mainstreaming climate adaptation in the US Department of Defense	Climate Services	2021	• Risk-based climate adaptation frameworks • Mainstreaming theory • Deliberation with analysis	Mixed-methods approach: • Workshops • Case Studies • Semi-structured interviews • Cross-project synthesis • Scenario modeling	• Southwestern USA • International comparison: (e.g. United Kingdom and Australia)	• 4 U.S. military installations • 16 interviews • Additional interviews • 1 cross-project workshop (21 participants)

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34	Rothe, D. L. & Collins, V. E.	Planetary Geopolitics, Space Weaponization and Environmental Harms	British Journal of Criminology	2023	• Green Criminology • Zemiology • Politics of Verticality (weizman) • Prospective Criminology (Friedrichs) • Anthropocene and Slow Violence (Nixon)	• Retrospective analysis • Prospective analysis • Critical literature review	• USA • China • Russia • Also mentions India and European countries	Study does not use empirical units or statistical subjects
35	Ahmed, Z., Ahmad, M., Murshed, M., Vaseer, A. I. & Kirikkaleli, D.	The trade-off between energy consumption, economic growth, militarization, and CO2 emissions: does the treadmill of destruction exist in the modern world?	Environmental Science and Pollution Research	2022	• TOD Theory • EKC Hypothesis	• Cross-Sectional Augmented Autoregressive Distributed Lag (CS-ARDL) • Augmented Mean Group (AMG) Estimator • Westerlund Cointegration Test • Panel Unit Root Tests (CADF and CIPS) • Granger Causality Test (Dumitrescu-Hurlin)	22 OECD countries: USA, UK, Germany, France, Japan, Canada, Australia, South Korea, Italy, Spain, Netherlands, Sweden, Norway, Finland, Austria, Belgium, Ireland, Portugal, Mexico, Chile, New Zealand, Turkey	• 22 countries • 50 years of annual data • 5 key variables

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36	Saba, C. S.	CO2 emissions-energy consumption-militarisation-growth nexus in South Africa: evidence from novel dynamic ARDL simulations	Environmental Science and Pollution Research	2023	• Environmental Kuznets Curve (EKC) Hypothesis: • Treadmill of Destruction (TOD) Theory • Endogenous Growth Theory • Neoclassical and Keynesian Growth Theories	• Dynamic Autoregressive Distributed Lag (ARDL) Simulations • Frequency Domain Granger Causality Tests • Unit Root and Cointegration Tests • Diagnostic Tests • Impulse Response Analysis	South Africa	• One country • Four main variables • Time series data over 60 years
37	Meliande, N. M., Oliveira, M. S., Pereira, A. C., Balbino, F. D'M. P., Figueiredo, A. B. H. d. Silva, Monteiro, S. N. & Nascimento, L. F. C.	Ballistic properties of curaua-aramid laminated hybrid composites for military helmet	Journal of Materials Research and Technology	2023	• Composite materials theory • Ballistic impact theory • Hybridization theory	• Experimental fabrication • Ballistic testing • Residual velocity and energy measurements • Statistical analysis	Brazil • Brazilian Army Technology Center • Military Institute of Engineering • Brazilian Army Test Center	5 composite types × 6 tests = 30 ballistic test events

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38	Scharsack, J. P., Koske, D., Straumer, K. & Kammann, U.	Effects of climate change on marine dumped munitions and possible consequence for inhabiting biota	Environmental Sciences Europe	2021	Environmental toxicology and climate impact theory	Narrative literature review	Baltic Sea and North Sea with specific attention to: • Germany • Poland, Denmark, and Sweden	• Multiple contaminated sites • Several species • Numerous chemical compounds
39	Mardiyati, Y. Putra, D. A., Fauziah, L., Rachman, O. A., Hariyanto, A. & Steven, S.	Development of sansevieria trifasciata/natural rubber composites for a soft body armor application	Composites Part C: Open Access	2023	• Fiber-matrix interaction theory • Ballistic impact and energy absorption principles • Finite Element Analysis (FEA)	• Experimental laboratory methods • Material optimization • Composite fabrication • FEA	Indonesia	• 6 fiber treatments • 7 rubber matrix formulations • 3 composite configurations • Ballistic simulation across 6 thickness levels

No.	Authors	Title	Journal	Year	Theory	Methods	Region	N
40	Kim, I.	Oiling the War Machine? The Fuel Dilemma and Warfighting Capability	International Studies Quarterly	2023	Fuel dilemma • Military logistics and strategy • War-fighting capability • Resource-based constraints in conventional warfare	Qualitative, comparative case study approach: • Typological theorization of fuel management practices • Historical analysis of three illustrative cases • Descriptive analysis to explore the operational and strategic consequences of fuel logistics	• Japan (Imperial Japanese Navy during WWII) • China (Chinese People's Voluntary Force during the Korean War) • Vietnam (Viet Cong and PAVN during the Vietnam War)	Three major historical cases: • Minimalism – Viet Cong and PAVN (Vietnam War) • Control – CPVF (Korean War) • Gamble – IJN (Pacific War, WWII)

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41	Tiwari, R., Mishra, R., Choubey, A., Kumar, S., Atabani, A. E., Badruddin, I. A. & Khan, T. M. Y.	Environmental and economic issues for renewable production of bio-jet fuel: A global prospective	Fuel	2023	Sustainability and environmental impact theory particularly focusing on LCA and techno-economic analysis.	• Comparative analysis of bio-jet fuel production pathways • Techno-economic evaluation of feedstocks and conversion technologies. • Environmental impact assessment • Review of policy frameworks and case studies from various airlines and countries.	• India, China, USA, Indonesia, Brazil, Canada, European Union, and Saudi Arabia. • Case studies from airlines in New Zealand, Japan, Mexico, Germany, UK, Australia, and others	22 commercial airline flights
42	Santos, N. P.	Hydrogen in the Portuguese Navy: A case study	International Journal of Hydrogen Energy	2022	Strategic planning theory, particularly using the SWOT analysis framework	• Document analysis • SWOT analysis • Strategic planning	• Portugal • References hydrogen-related developments in Germany, Norway, Japan, Dubai, and Belgium	• 1 patrol ship • 1 passenger ship References: • 2 Flagships • 1 HySHIP

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43	Polyakov, V., Kadoya, W., Beal, S., Morehead, H., Hunt, E., Cubello, F., Meding, S. M. & Dontsova, K.	Transport of insensitive munitions constituents, NTO, DNAN, RDX, and HMX in runoff and sediment under simulated rainfall	Science of the Total Environment	2023	Environmental fate and transport theory, particularly focusing on the hydrological transport mechanisms of pollutants	• Rainfall simulation experiments • High-performance liquid chromatography (HPLC) • Particle size fractionation and mass balance calculations. • Statistical analysis via linear regression and stepwise variable selection	Soil samples from two U.S. military sites: • Florence Military Reservation, Arizona • Aberdeen Proving Ground, Maryland • Energetic residues were collected from Alaska	36 plot simulations were conducted